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An exploratory study of teachers' critical thinking in elementary language arts classrooms

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An Exploratory Study of Teachers' Critical Thinking in Elementary Language Arts Classrooms

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DEDICATION

This dissertation is dedicated to *Thomas McGowan*,

father,

philosopher,

and friend.

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When undertaking challenges which involve life changes, it is wise to maintain a sense of balance. So much appreciation goes to those who pulled, pushed, and prodded, but ultimately, allowed me to do it my own way.

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ABSTRACT

This exploratory study examined how well elementary language arts teachers participating in a federal project to raise students' critical thinking abilities scored on tests of critical and creative thinking. Furthermore, it investigated the ways in which these teachers of the language arts have developed their understanding of critical thinking skills, what types of training they bring to the classroom which might enhance the teaching of critical thinking skills, and the methods by which they foster critical thinking in the classroom. Finally, this study examined the relationship among teacher scores on critical and creative thinking tests, their professional development hours, and results on a scale of teacher behaviors.

The study was a mixed design that employed the Watson-Glaser Critical Thinking Assessment, the Abbreviated Torrance Test for Adults, the Wenglinsky Questionnaire, and an interview protocol. Descriptive statistics were used to analyze data and a correlation was run to determine if a relationship existed between tested dimensions.

Overall, the research findings suggest that experimental teachers sought professional development options that dealt with higher order thinking skills more regularly than did comparison teachers. Familiarity with higher order thinking skills may have enabled this group to achieve a slightly higher score on a critical thinking test existed. Implications for practice suggest that further research should replicate this study with a larger sample size to substantiate findings.

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Chapter 1

Introduction to the Study

The Secretary's Commission on Achieving Necessary Skills (SCANS) report explicates a three-part foundation of intellectual skills and personal qualities considered essential to work-force competencies. The foundation includes the basic skills of reading, writing, arithmetic, mathematics, speaking and listening; personal qualities such as individual responsibility, self esteem, sociability, self-management, and integrity; and thinking skills which include creative thinking, decision-making, problem solving, seeing things in the mind's eye, knowing how to learn, and reasoning (SCANS, 1991).

Critical thinking and creative thinking are often referred to as higher order thinking skills (Paul & Elder, 2001). These two levels of thinking are equivalent to Bloom's (1956) hierarchical levels known as evaluation and synthesis, respectively. Scriven and Paul (2005) define this complex process as the "intellectually disciplined process of actively and skillfully conceptualizing, applying, analyzing, synthesizing, and/or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action" (Defining Critical Thinking, p. 1).

Gifted education is particularly "recognized for advancing the introduction of innovative instructional practices into the classroom, such as inquiry learning, critical and creative thinking skills, higher order questioning strategies, [and] metacognition" (VanTassel-Baska, et al., 2005, p. 5) in response to gifted students' "capacity to perceive information and use it productively to a unusual degree" (Parks, 2005, p. 249). According to Cotton's (2001) review of 56 key documents on the teaching of higher order thinking skills, 22 of which are research studies or evaluations, higher order

thinking skills enhance academic achievement in such a way that over time thinking skills instruction accelerates student learning gains. When defined as "the mental process on the basis of which we make reliable judgments on the credibility of a claim or the desirability of a course of action" (Mohanan, 1997, p. 3), higher order thinking skills are habits which educators should desire to instill in their students.

Unlike critical thinking, creative thinking focuses on less analytical, goal-oriented, and rational strategies and more on holistic, emotional and intuitive methods of thinking (Huitt, 1998), even though "these mental processes are functionally interrelated" (Parks, 2005, p. 250). Creative thinking employs fluency, flexibility, originality, and elaboration (Cotton, 2001) for the optimal generation of abundant ideas built on each other in the pursuit of that which is novel. Some researchers view creativity as a component of gifted education (Passow, 1993) and attempt to include it in assessments of student eligibility for gifted services in the schools. Other researchers consider creativity to be a trait that overlaps with giftedness (VanTassel-Baska, 1998). Gagne (1995) defines creativity as an aptitude domain of giftedness, specifying that creativity "is a natural ability having a clear genetic origin" (p. 107). Another view researchers promulgate is that creativity exists merely as a scaffold for supporting critical thinking (Runco, 1999), regardless of the fact that "creativity has been seen as the only uniquely 'human' characteristic, defining an area where, for instance, microelectronics cannot go" (Cropley, 1999, p. 536). Despite the large body of creativity research, there is a lack of consensus regarding a cohesive definition of creativity.

Statement of the Problem

While educators have shown considerable interest in higher order thinking skills during the last decade, processes and principles of sound reasoning are seldom developed meaningfully in the classroom. "Virtually all informed commentators agree that schooling today does not foster the higher order thinking skills and abilities which represent the basics of the future" (Paul & Nosich, 2005, p. 1). According to Mary Kennedy, "national assessments in virtually every subject indicate that although our students can perform basic skills pretty well, they are not doing well on thinking and reasoning" (Kennedy in Paul, p. 2). For example, American students are adept at computing but not reasoning; they have mastered writing and correcting sentences but not the ability to prepare logical arguments (Kennedy in Paul, p. 2).

Research at the university level evidences that an overwhelming majority of faculties do not possess an implicit, coherent definition of critical and creative thinking even though they purport to teach these skills in their university classrooms (Paul, 2004). Additionally, university faculties generally confuse the active involvement of students in classroom activities with critical thinking in those activities (Paul, 2004). Reasoning, an important component of critical and creative thinking, is even less understood at the elementary level. A recent evaluation of the statewide California writing test indicates lack of understanding by teachers regarding teaching and assessing reasoning skills (Paul, 2004). If the teacher is the key focus and area of concern in fostering the teaching of higher order thinking skills (Hargrave, 2005), then teachers must learn to design, analyze, and objectively evaluate assignments that require critical thinking skills (Paul, 2004). Since "those we label gifted possess special characteristics that affect their ability to learn

to a significant degree, and [since] they will not reach their full educational potential unless we modify their curricula substantially" (Borland, 1988, p.2.), teaching higher order thinking skills offers processes that are practical and easily accessible to classroom teachers. It provides teachers with structures to develop skills in critical and creative thinking. Additionally, teaching higher order thinking skills gives children access to a means of linking different areas of knowledge and develops skills that "transfer across, apply to, and enhance any field of inquiry a student may encounter" (Van Tassel-Baska, 1994. p.4). Unfortunately, "lecture, rote memorization and short-term study habits are still the norm" (Paul, 2005, p.1) in most gifted classrooms to date. A federal research project called Project Athena that involved scaling up of language arts instruction with minority populations, has provided some evidence of the capacity of teachers to infuse higher order thinking skills into their students' repertoires of skills (VanTassel-Baska, Quek, Feng, in press) .

Context of the Study

One primary contextual issue for considering this study included potential reforms based on a growing consensus regarding the skills needed for success in college and in the marketplace (Bassett, 2005). The SCANS (1991) report maintains that globalization of businesses and the rapid growth of technology have not been reflected in how students are prepared for college or for the workplace. The current-data driven environment coupled with state and national standards explicitly states *what* to teach but not *how* to teach, creating a lack of relevance between school knowledge and marketplace knowledge.

A second contextual issue centered on teacher quality (NCLB, 2002a) through examining teacher inputs, defined by Wenglinsky (2000) as teacher level of education, major, number of years teaching, number of professional development days in various categories, and types of assessment used in the classroom. Various combinations of teacher inputs combined with specific classroom practices such as the teaching of higher order thinking skills melds external and internal influences on students and may result in higher student achievement (McLaughlin & Talbert, 1993; Wenglinsky, 2000). Strategies such as individualization of instruction and collaborative learning also enhance the teaching of higher order thinking skills (Wenglinsky, 2000), indicating that teacher quality may be linked to specific forms of teacher professional development.

A third consideration was the necessity for teachers to have minimum baseline knowledge of the concept of critical and creative thinking (Paul, 2004). Teacher trainers must be able not only to explain and differentiate between the concepts, but they should also be able to consistently model instruction in critical and creative thinking in classroom planning, policy, and instruction.

Statement of Purpose

This study sought to determine how well elementary school teachers of the language arts scored on tests of critical and creative thinking. Furthermore, it investigated the ways in which elementary school teachers of the language arts have developed their understanding of critical thinking skills, what types of training they bring to the classroom which might enhance the teaching of critical thinking skills, and the methods by which they foster critical thinking in the classroom. Generally, research on critical and creative thinking uses a quantitative approach "in which statistical analysis

identifies significant correlates of student scores on [various] standardized" (Tsui, 2000, p. 422) measures. This study used both quantitative and qualitative methods in an attempt to answer the research questions.

Methodology

This exploratory study sought to explore how well elementary language arts teachers involved in the fourth year of a special language arts program, Project Athena, for high ability learners scored on tests of critical and creative thinking. Language arts teachers involved in the project were administered the Watson Glaser Critical Thinking Appraisal-Form S (Harcourt Brace, 2005). The Watson-Glaser Critical Thinking Appraisal (WGCTA) defines critical thinking in terms of five domains: inferences, deductions, interpretations, recognition of assumptions, and evaluation of arguments (Watson & Glaser, 1980). WGCTA has been found to be predictive of success in teaching critical thinking skills (Heraty & Morley, 2000; Wood, 1981). It has been used both to assess improvement of critical thinking skills in individuals prior to training sessions and after they implement skills in various settings as well as for conducting research on the construct itself (The Psychological Corporation, n.d.). The WGCTA may be found in Appendix A.

Additionally, teachers were administered the Abbreviated Torrance Test for Adults (Scholastic, 2002), a test designed to measure adult creativity. The Abbreviated Torrance Test for Adults (ATTA) has the advantage of requiring less time than the full Torrance battery by combining verbal and figural activities. Repeated longitudinal studies of the test have produced evidence of real-life creative achievement and test

results (Torrance, 2000). Scores were calculated according to test protocols. The ATTA may be found in Appendix B.

Because test results reflected individual abilities at one point in time and may be subject to internal and external threats to reliability and validity (Gall, Gall & Borg, 2003), teachers selected for this study were derived from a statistical analysis of the Classroom Observation Scale-Revised (COS-R), provided a sub-sample of Project Athena teachers who repeatedly achieved scores which ranged between 2.5 and 3.0 (effective) on a scale of 3 on the critical and creative thinking sub-categories of the COS-R. Cases were purposeful, comprising an extreme group sample that "[is] information rich because [it is] unusual or special in some way, such as outstanding successes or notable failures" (Patton, 2002, p. 231). Cases in this population consisted of twelve teachers with teaching experience ranging from five to 35 years. All of the teachers hold current teaching licenses; five have earned bachelor's degrees while the remaining seven have achieved master's degree status. Individually, these teachers spend approximately 26 hours during the course of the school year pursuing professional development activities offered both by the district and by outside agencies. It was expected that even though a narrow range of scores were selected from COS-R averages across two years of Project Athena implementation, this sample would yield an equally wide range of conceptions regarding higher order thinking skills as bolstered by teacher input and interview data.

Interviews were semi-structured using the interview protocol found in the *California Teacher Preparation for Instruction in Critical Thinking: Research Findings and Policy Recommendations* (Paul, Elder & Bartell, 1997), a research study conducted

to pursue similar queries involving teachers' conceptualization and implementation of critical thinking. Interviews were audio-taped, lasted approximately one hour, and were transcribed verbatim.

All teachers who were interviewed were administered an Inputs/Activities Questionnaire based on Wenglinsky's (2000) criteria and designed to probe Research Question #1. The Inputs/Activities Questionnaire may be found in Appendix C. No reliability or validity information could be found concerning Wenglinsky's questionnaire and repeated attempts to contact Professor Wenglinsky both electronically and by telephone went unanswered.

Research Questions

The following research questions guided the study:

1. Are there differences between experimental and comparison teachers participating in Project Athena with respect to training and experience in teaching critical thinking and other inputs of advanced learning that might affect the use of higher order thinking skills?
2. What differences are there between experimental and comparison teachers participating in project Athena on tests of critical thinking?
3. What differences exist among Project Athena teachers on a test of Creative Thinking?
4. How do Project Athena experimental and comparison teachers define critical thinking?
5. How are critical thinking activities employed in these classrooms? Do they vary between experimental and comparison teachers?

Significance of the Study

A study's significance, particularly one that uses qualitative inquiry, reflects the researcher's paradigm. Therefore, it is important to note that the following areas of significance are subject to the interpretivist paradigm which involves "attaching significance to what was found, making sense of findings, offering explanations . . . considering meanings . . . and otherwise imposing order on an unruly but surely patterned world" (Patton, 2002, p. 480). There are three notable areas of significance which ground this study. First, teaching higher order thinking skills to younger children has the potential to result in increased competencies of students as they progress through secondary school, college, and ultimately transition to the workplace. However, unless a cohesive definition of higher order thinking skills exists and is broadly implemented; disciplined thinking may be subject more to chance than result from rigorous training.

A second area of significance involves potential opportunities for professional development. Examining teachers' definitions of higher order thinking skills and identifying subsequent emergent themes from subjects' shared stories may serve to target gaps between thinking and practice and assist in documenting the problem at the teaching level. Additionally, assessing teachers' abilities to think critically and creatively themselves may serve to establish a critical thinking baseline for use in teacher preparation programs.

A third area of significance includes examining teacher inputs for patterns related to the teaching of higher order thinking skills. It attempts to find support for the existence of transfer of external influences on educators' lives to classroom practices.

Definition of Terms

Appropriate terms used in this study are defined below in order to provide specificity within the study. Where possible, definitions commonly accepted in the field of gifted education were used and cited.

Bloom's Revised Taxonomy. The revised taxonomy incorporates both the kind of knowledge to be learned and the process used to learn, thereby linking the knowledge domain with the cognitive process domain (Anderson & Karthwohl, 2001).

Higher order thinking. Thinking focused on the cognitive process dimension of Bloom's Revised Taxonomy. These are: understand, apply, analyze, evaluate, and create (Anderson & Karthwohl, 2001).

Critical thinking. The Watson-Glaser Critical Thinking Appraisal-Form S (Harcourt-Brace, 1994) considers critical thinking to be a composite of knowledge, attitudes, and skills. The test developers consider critical thinking abilities to be related to the ability to define a problem, to select pertinent information for the solution to a problem to recognize stated and unstated assumptions, to formulate and select relevant and potential hypothesis, and to draw valid conclusions as well as to judge the validity of inferences (Watson & Glaser, 1994).

Creative thinking. The recognized characteristics of creative thinking as established by the Torrance Test of Creative Thinking (TTCT) are fluency, flexibility, and elaboration. The ability to produce quantities of ideas quickly demonstrates fluency while the aptitude to provide a variety of ideas or use a variety of approaches in thinking through a task is known as flexibility. Elaboration, on the other hand, refers to the level of detail present

in the thought process (Torrance & Goff, 1989). Other researchers include the concept of novelty in their definition of creativity as well.

Professional Development. Professional development is an intentional, ongoing, systemic process that takes a variety of forms to include training, observation/assessment, involvement in a development/improvement process, study groups, inquiry/action research, individually guided activities, mentoring (Guskey, 2000).

Teacher efficacy. The belief that "teachers can influence how well students can learn, even those who may be considered difficult or unmotivated" (Guskey & Passaro, 1994, p. 628).

Teacher inputs. Teacher level of education, major, number of years teaching, number of professional development days in various categories, and types of assessment used in the classroom (Weglinsky, 2000).

Chapter 2

A Review of the Literature

Introduction

Literature on higher order thinking skills investigated in this exploratory study involve both critical and creative thinking skills. Because of the potential importance professional development has on the impact of the study's findings, a review of relevant professional development literature has been included as well.

Several themes emerged during a review of the literature regarding critical thinking skills. Such themes included competing definitions, desired characteristics of a critical thinker, and critical thinking in the disciplines. Relevant research studies focused critical thinking on specific areas of teaching and learning and measures of critical thinking. Table 1 reflects sorting the critical thinking literature into these pertinent categories.

Creative thinking is often viewed as a form of critical thinking. The creative thinking literature attempted to define creative thinking, discussed the development of creativity, and provided options for educators to promote thinking in their classrooms. Research studies selected for this review focused on students and teachers as creative thinkers as listed in Table 2. Where merited, articles were repeated across categories.

A brief overview of current professional development literature is included. Selected professional development literature is listed in Table 3.

Background on Critical Thinking

Definitions of Critical Thinking

Critical thinking is a concept adopted by education from the work of psychologists and philosophers. Some researchers considered it a rational skill that exists

solely for solving problems, while others defined it more broadly and include cognitive, social, and affective components in their descriptions (Daniel, et. al, 2004). The most renowned definitions of critical thinking belonged to Johnson (1992), Ennis (1993), Lipman (1991), McPeck (1991), Paul (1993) and Siegel (1988), and much of the work accomplished on critical thinking in education cited their work.

Most definitions of higher order thinking invoked Bloom's Taxonomy as a framework. Critical thinking generally embodied the top three levels of Bloom's Taxonomy to include analysis, synthesis, and evaluation (Georgia Critical Thinking Skills Program, n.a., 2005). The Louisiana Teacher Assistance and Assessment Program (LTAAP) added that "critical thinking is convergent thinking . . . assuring the worth and validity of something existent" (LTAAP, 2000, p. 25). Definitions of critical thinking coupled with lists of relevant skills, operations, or strategies permeated the literature. For example, critical thinking operations included, but were not limited to, distinguishing fact from value claims, distinguishing relevant from irrelevant information (Cotton, 1991; Hudgins & Edelman, 1986), determining factual accuracy of statements, determining credibility of source information (Beyer, 1985; Cotton, 1991), identifying ambiguous claims or arguments, identifying assumptions, detecting bias, identifying logical fallacies, recognizing inconsistencies in a line of reasoning, and determining the strength of an argument or claim (Louisiana Teacher Assistance and Assessment Program, 2000). Potentially the most definitive definition of critical thinking hailed from the work of Paul & Elder (2001) who espoused that "no one definition of critical thinking will do" (p. 371). Their rationale for this statement emerged from extant definitions and their limitations.

Limitations aside, Paul & Elder (2001) admitted that most definitions of critical thinking possess a common core of meaning, namely that of "upgrading the quality of human thinking by the cultivation of special skills, abilities, and insights that enable thinkers to take mindful command of their thinking and related behavior" (p. 374). Additionally, they identified common denominators of critical thinking to include the systematic monitoring of thought, clarity, accuracy, relevance, depth, breadth, logic, and perspective, as well as thinking which is possessed of an informational base and centered on interpretation involving a concept entailing both assumptions and implications (Paul & Elder, 2001).

Literature combining the importance of higher order thinking skills and giftedness was less abundant than literature that solely discusses these skills. However, many authors touted higher order thinking skills as necessary for the development of gifts. For example, Shore & Kanevsky (1993) declared that higher order thinking skills are thinking processes which are "an important component of a contemporary conception of giftedness and its development" (p. 133). Parks (2005) cited gifted students' capacity to "analyze information intuitively and efficiently" (p. 249) as the rationale for teaching these students to think critically and to measure their efforts appropriately.

Characteristics of a Critical Thinker

Critical thinking scholars were convinced that "the ideal critical thinker can be characterized not merely by . . . cognitive skills but also by how he or she approaches life and living in general" (Facione, 2004, p. 8). From this rationale, certain dispositions were identified as being characteristic of a good critical thinker. These dispositions included systemic thinking, inquisitiveness, judiciousness, analysis, open-mindedness,

confidence in one's reasoning, and seeking the truth (Delphi Method, 1990). To be a good critical thinker, such dispositions must pervade the personality. For example, it is not sufficient to be inquisitive; one must be inquisitive about a wide range of issues (Facione, 2004). Likewise, open-mindedness must be all inclusive to include divergent world views.

Paul elevated characteristics of a critical thinker to a higher level to include the development of specific intellectual traits (2001). Moreover, Paul applied standards to both the elements and traits of critical thinking, providing an elegant framework on which to ground the elements and traits of reasoning.

Paul & Elder (1992) maintained that critical thinkers routinely apply the intellectual standards to the elements of reasoning in order to develop intellectual traits or characteristics, so it is tantamount that critical thinkers are cognizant of and understand these standards. Applying standards to the elements of reasoning not only contributed to developing intellectual characteristics, but broadens the scope of Bloom's Taxonomy as well (Paul, 2004). Additionally, because the standards were highly applicable to gifted education, they were worthy of the detailed discussion which follows.

The first standard encompassed clarity. Clarity involved elaboration and illustrative discussion whether verbal or written. It required examples from more than one facet of an issue so that the listener or reader can make connections among disparate thoughts. Paul & Elder (1992) described clarity as the gateway standard, meaning that without clarity, productive thinking will cease. Very young gifted students should be cognizant of and practice clarity in everyday speech (Silverman, 1998). They should be

taught to choose the most apt word from among a choice of words. For example, the phrase, *she said* could become *she exclaimed, she yelled,* or *she whispered.*

Accuracy, the second standard, demanded evidence (Paul & Elder, 1992). Evidence should be garnered from multiple sources and, although it may be conflicting, should provide a basis from which to search out the truth (VanTassel-Baska, et. al, 1998). Accurate statements reflected clarity as well as that which is correct. Young gifted children should be aware of and be able to select a variety of resources from which to gather accurate information. Older elementary-age students should be able to distinguish reliable sources from those that are less reliable or simply sensational in nature.

Paul & Elder (1992) considered precision to be the third standard. Precision stressed specificity. It built on clear, accurate statements but required detailed facts without which ambiguity reigns. Young gifted children savor precision (Tannenbaum, 1992) especially detailed-oriented learners.

Relevance, the fourth standard, evidenced connections between and amongst facts, details, and the issue at hand (Paul & Elder, 1992). It linked seemingly disjointed thought processes so that the reader or listener acquired distinct appreciation for the significance of the thought to the issue. Young gifted students may become quite adept at discerning "goodness of fit," (Gagne, 1992) while older elementary-age students can capably distinguish relevant statements from irrelevant ones.

Depth, the fifth standard, negated superficiality (Paul & Elder, 1992). It examined the complexities of an issue or problem in such a way that it accounts for the most pervasive factors of a multifaceted problem. Young gifted students, particularly those with heightened moral sensitivity (Monks & Mason, 1992), should consider

dualities of an issue while older elementary-age students should strive to think through the peculiarities or nuances of an issue or problem.

Closely aligned to depth was the standard involving breadth. Breadth considered more than one perspective or point of view (Paul & Elder, 1992). It examined conflicting theories regarding potential solutions to problems and sought to pinpoint consistencies between ostensibly inconsistent ones. Gifted students of all ages should experience increasingly adept ability to examine varying perspectives and apply information gleaned to a wide variety of situations (VanTassel-Baska, 1998).

Logic required mutually supportive thoughts which are bolstered by consistent data (Paul & Elder, 1992). Implications derived from logical thinking lead to novel, testable theories. Young gifted children can distinguish between logical and illogical thoughts through reflection and exaggeration (Coleman & Cross, 2001). Older students should exhibit knowledge of fallacious thinking and be able to modify faulty reasoning.

Significance involved discarding extraneous ideas in favor of a central idea of great importance (Paul & Elder, 1992). Focus on a central problem was heightened by eliminating that which is irrelevant. Young gifted students should consider more than one idea and substantiate reasons for choosing the most significant one (VanTassel-Baska, 1998). Older students should be able to consider multiple ideas and articulate support for discriminating between significant and insignificant ideas.

Fairness heightened individual biases and forces reasoning about stakeholder emotion (Paul & Elder, 1992). It identified impediments to objectivity and misrepresentation due to prejudice on the part of an individual. Young gifted children often present strong views of fairness and equity (Csikszentmihalyi, 1990). As they

develop, children should be guided to consider their level of objectivity and their rationale for taking a stance on a given issue.

Completeness considered possibilities. It allowed for reflecting on accomplished thought processes and defines what has been omitted or overlooked (Paul & Elder, 1992). Young gifted students will identify glaring omissions to ideas and thoughts, while older students should be able to discern potential paths for investigation (VanTassel-Baska, 1998).

Critical Thinking in the Disciplines

During the twentieth century, the rationale for teaching critical thinking skills was linked to responsible citizenship, to employability in an increasingly global marketplace, and to standing as the hallmark of the quintessential educated individual (Cotton, 1991). Despite the increasing recognition of the importance of critical thinking skills, researchers concurred that the ability to reason critically is not reflected by high scores on critical thinking assessments (Norris in Cotton, 1991) even though "educators now generally agree that it is in fact possible to increase students' . . .critical thinking capacities through instruction and practice (Cotton, 1991). Specific thinking skills programs such as the Comprehensive School Mathematics Program, Talents Unlimited, Creative Problem Solving, and Kids Interest Discovery Study Kits were representative of thinking skills programs present in schools that have been studied by researchers and found to be effective in the advancement of critical thinking skills (Cotton, 1991).

Other researchers, particularly in the arena of gifted education, endorsed connecting thinking skills to content areas in order to effectively embed discipline specific language into the thinking process (VanTassel-Baska, 1998). This notion was

supported by researchers in general education who contend that "successful reasoning within the academic subjects requires adherence to disciplinary differences" (Langer, 1992). For example, questioning and analysis in science may be viewed as *explication* while the same skills might be considered *interpretation* in the language arts classroom (Langer, 1992).

Weinstein (1995) echoed this view when he discussed the language of the discipline, considering language as multi-dimensional. He conceived of language as "a set of paradigmatic practices that underlie that particular concepts and argument types characteristic of a discipline" (p. 7). Asking students to utilize discipline-specific language allows for precise communication among learners and enhances "the relationship between the critical thinker and the community that he or she addresses" (Weinstein, 1995). For instance, biological thinking may be viewed as a "special way of thinking about living things," (Paul & Elder, 2001, p. 136) while historical content can be thought of as a "special way of thinking about events in the past" (Paul & Elder, 2001, p. 136).

Critical thinking in content areas also allows learners to organize concepts within the discipline in ways which were characteristic of the discipline (Weinstein, 1995), thus elevating critical thinking skills from a one size fits all scenario to a targeted thinking tactic. The tactic then supports skillful and responsible thinking which focuses on judgment and was supported by specific criteria that is sensitive to context (Weinstein, 1995). Such thinking develops in young children when they construct meaning from existing relationships in context by "providing an example, providing a counterexample,

questioning, proposing a solution, creating new relationships, inventing a problem, providing context, etc." (Daniel, 2004, p. 297).

Relevant Critical Thinking Literature

Students and Critical Thinking

Gierl's 1997 study examined the question of whether or not researchers could accurately predict which lower order thinking skills math students in grade seven would use when asked to design a test of a math unit they had just completed in class. Gierl used Bloom's taxonomy as a conceptual framework for the study, and questions designed and answered by the students were categorized using the taxonomy. The research sample consisted of 30 seventh grade students. Sixteen of the students were male and 14 of the students were female. Data sources included student demographics, records of achievement to determine if students were considered high achieving or low achieving in general so that a difference in cognitive skills might be determined at the onset of the study. Findings included the fact that 54% of student responses matched the cognitive levels anticipated by the researchers. Predictions were also accurately made as to which processes would be used by high achieving students and which would be used by lower achieving students at a 56% match compared to a 51% match. The study's major contribution was confirmation of the fact that the intentions of teachers, namely the fostering of higher order thinking skills, were not being matched by student responses.

Jackson's 2000 Master of Arts dissertation acknowledged that mathematics is a discipline in which elementary students show low performance in applying critical thinking. Jackson designed a study that granted students ownership of their mathematical

learning by allowing them to approach math problems in a variety of interdisciplinary ways including drawing, using formulas, counting, and journal writing. The conceptual framework used in this study involved multiple intelligences coupled with Bloom's taxonomy. The study included a pre-test/post-test design. The sample consisted of 17 sixth grade students, nine of whom showed "significant improvement" (Jackson, 2000, p. 6) in higher order thinking skills with respect to learning achievement in mathematics. Jackson also noticed improvements in the affect and attitude of these young mathematicians as evidenced by journal writing. A significant contribution of this study was the implication that higher order thinking skills are cross-disciplinary and must be continuously addressed as students progress through the stages of schooling and eventually into the marketplace.

A group of fourth grade students identified as having above average math ability were researched in Clements' & Burns' 2000 study involving student-developed strategies for determining turn and angle measure. Rotation and measurement are concepts critical to learning geometry. No specific theoretical framework was used to approach this study; however, the researchers drew on their expertise with the computer program Logo when used with young children.

The sample for this study included 14 fourth grade students who had been identified as having high mathematical ability by their teachers. These students participated in a pull-out program offered by two teachers who desired to offer enrichment to these students and because the students were reported to have different learning styles. Data collection included field notes taken by the researchers during whole class lessons, video tapes of students working at computers, and questioning to

clarify student thinking during task performance. Student work was also considered during data analysis. The study's design became one of case studies as the researchers studied videotapes and notes.

The researchers found that students use strategies such as utilizing their bodies for movement as well as making numerical estimates when asked to judge rotation or turn measures. Mathematicians call this a 'guess and check' strategy. This strategy was replaced with others as students grew familiar with rotation and measurement. For example, students began to use mathematical tools such as protractors when asked to judge angle measurement. Most students could explain their thinking processes during tasks involving rotation and measurement.

This study's contributions included mapping the cognitive thinking processes of young children and the development of those processes as students become familiar with abstract concepts. Physical movements seemed to yield to mental images as students traversed from the concrete to the abstract, although the developmental process was not the same for all students.

Additional research involving critical thinking and students through case studies included Yehudit & Revital's 2002 study which attempted to determine whether higher order thinking skills of non-science majors could be improved in science classes involving biotechnology. The theoretical framework used for this study involves the Science for All reform movement currently underway in Israel. One strand of this reform movement mandated that students who do not major in science must select a science course that addresses the social, cultural, environmental, and political aspects of science so that they can apply moral reasoning and make critical decisions in a complex world.

The goal of the study was to investigate the abilities of non-science majors to use thinking skills when examining environmental and moral conflicts in the area of biotechnology.

The study's sample consisted of 200 non-science majors in grades 10-12. These students made up eight classes in six different high schools rendering variety both socio-economically and ethnically. Students were grouped into three different academic levels (low, intermediate, high) as determined by pre-test scores and teacher input. Six experimental teachers and seven control teachers took part in the experiment. The experimental teachers had majored in science and either had bachelor's or master's degrees in biology, environmental science, or chemistry. Experience ranged from 6 to 21 years of teaching.

Data sources included both pre- and post-tests, teacher interviews and student feedback. Pre- and post-tests were written by the researchers and were similar but not identical to each other. The tests probed knowledge, understanding concepts, application of knowledge to novel situations, questioning and argumentation skills and case studies with open-ended responses.

Because of their interest in determining whether students could improve their high order thinking skills abilities, the researchers examined higher order thinking skills separately when analyzing their findings. The researchers discovered that high ability students preferred assignments in which they could pose their own questions, while lower ability students tended to choose assignments that required systematic thinking. High ability students scored significantly higher than low ability students in the use of higher order thinking skills. Because there was choice offered with respect to which

assignments were done by which students, the researchers attributed this finding to the fact that students with high academic ability were better able to determine the level of difficulty involved in the assignments they chose. Students of both levels improved with respect to higher order thinking skills from the pre-test to the post-test.

The contributions of this study included the fact that when presented in an interdisciplinary manner, non-science majors can improve their higher order thinking skills by learning science. The researchers attributed much of the improvement in scores from the pre- to the post-test to the willingness of teachers to work in fields outside of their discipline in an interdisciplinary manner. Additionally, both teachers and students could benefit from the knowledge that low ability students can improve their higher order thinking skills ability.

Burbach's 2004 research study attempted to discover whether an introductory college level leadership course could increase critical thinking skills by encouraging active learning. There was much support in the literature that suggests active learning can increase critical thinking skills. This literature served as Burbach's theoretical framework.

The study's sample included 80 college students who were at least 19 but less than 35 years old. These students were enrolled in six sections of an introductory leadership course. Participants in the study included 57 men and 23 women, 26 of whom were freshmen, 21 were registered as sophomores, 14 as juniors, and 19 as seniors. All of the participants were volunteers.

The Watson-Glaser Critical Thinking Appraisal, Form B was used to collect data on these students. Five subtests including Inference, Recognition of Assumptions,

Deductions, Interpretation, and the Evaluation of Arguments made up the Watson-Glaser Critical Thinking Appraisal, Form B. The students completed the test at the beginning and at the end of the semester.

Using a t-test, the researcher ascertained that scores on the Deduction and Interpretation subtests were significantly higher at the end of the semester. However, the researcher determined that it was not possible to identify which active learning strategies had the most impact on student critical thinking scores. The key strategies used in the course included journal writing, service learning, small group discussion, scenarios, case studies, and questioning. This study's contributions included support for the idea that it is vital to teach critical thinking skills at all levels of schooling, particularly as Brubach reported that upper level students (seniors) scored lower than the lower classmen did on the pre-test.

Another study, undertaken in 2004 by Chin & Chaun in Taiwan, examined whether senior high school students' inclinations and ability to think critically and creatively could be predicted by a single aspect of their personality and psychological preferences. The conceptual framework for this study was grounded in Sternberg's theory of mental self-government which defined intellectual styles as "an interface between intelligence and personality" (Ching & Chaun, 2004, p. 33). Additionally, Jung's theory of personality types lent support to the relationship between thinking styles and personality types.

The study's sample consisted of 1,119 male senior high school students defined by Ching & Chaun as being in Grades 10 and 11. All participants volunteered to participate in the study. Demographic variables such as grades, school types, major, and

parent's educational level were examined. Data sources included the Thinking Styles Inventory, the Chopsticks Creativity Test, the Watson-Glaser Critical Thinking Appraisal, and the Myers-Briggs Type Indicator. Pearson correlations were calculated for each scale and are discussed in detail in the study. Results indicated that there is support for the notion that a relationship exists between an individual's thinking style and personality type. In particular, "liberal, legislative, judicial, hierarchical, monarchic, anarchic, global, local, and external thinking have significant correlation with creative thinking" (Ching & Chaun, 2004, p. 43), and introverts outperformed extroverts in making inferences, recognizing assumptions, and interpreting data. These results suggested that there might be merit in having teachers consider learning domains as well as ability testing when assessing their students.

Teachers and Critical Thinking

Lang wrote that "the teachers are the key change-agent in producing a thinking generation" (2001., p. 6) as he researched the effects of a thinking module on the dispositions of pre-service teachers in Singapore using Ennis' Concept of Critical Thinking and Facione's California Critical Thinking Dispositions as a theoretical framework. Lang's interest in these frameworks centered on the possibility that a direct relationship exists between critical thinking ability and critical thinking dispositions.

Lang's sample consisted of 29 pre-service teachers. The teachers were randomly assigned to an experimental or control group. Critical thinking dispositions were measured using the California Critical Thinking Dispositions Inventory (CCTDI). The inventory used a 6-point Likert scale to determine seven dispositions including truth-seeking, open-mindedness, analyticity, systematicity, critical thinking, self-confidence,

inquisitiveness, and cognitive maturity. Students were then exposed to a thinking module in order to determine if their critical thinking dispositions would change. Lang determined that subjects exposed to the critical thinking module attained a higher post-test score on the CCTDI. The areas of inquisitiveness, analyticity, critical thinking, and self-confidence improved as a result of the module for pre-service teachers in the experimental group. Lang determined that dispositions toward critical thinking could be improved upon through targeted instruction designed for this purpose.

Improving the higher order thinking skills of gifted students have been a target of gifted education for the past fifty years (Roberts, Ingram & Harris, 1992). Roberts, Ingram & Harris used the Ross Tests of Higher Cognitive Processes to determine the effects of a pull-out program and a school-wide enrichment program on the higher level thinking skills of both gifted and regular education third, fourth, and fifth grade students.

The theoretical frameworks for this study included skills found both Bloom's Taxonomy (comprehension, application, knowledge, analysis, evaluation, synthesis and the work of Guilford (cognition, convergent production, memory, divergent production, productive thinking, and evaluation-decision-making and planning skills). Students from two schools that were comparative in size, ethnicity, and socio-economic status were used in this study. The treatment school had a pull-out program for identified gifted students in the third, fourth, and fifth grades, and an enrichment program implemented throughout the school for all students. The comparison school had no such programs and was selected solely for the commonalities it possessed with the experimental school.

The treatment school selected 30 gifted students for participation in the research study after being administered the Ross Test of Higher Cognitive processes. Each grade

level was represented by ten students. Average ability students included 18 third graders, 20 fourth graders, and 18 fifth graders. The comparison school's sample consisted of 8 third graders, 10 fourth graders, and 9 fifth graders who were identified as gifted, and 19 students from each grade level represented the average ability sample from the comparison school.

The study's design was a pre-test/post-test control group. Analysis of covariance (ANCOVA) was used to determine the effect of treatment on gifted and average ability students by school and by grade.

The intervention in this study consisted of a gifted pull-out program and a whole school enrichment program in a modified version of Renzulli's Triad Model. Gifted students experienced a wide-range of academic subjects and strategies designed to increase higher order thinking skills during the pull-out program. They were trained in skills already mentioned that encompass Bloom's Taxonomy and Guilford's thinking skills. Average achieving students in the treatment school worked on similar activities while their gifted peers were pulled-out for small group instruction. In the comparison school, students of all levels worked on the school district's regular curriculum.

The researchers found that both gifted and average achieving students scored higher than students who received no instruction in higher order thinking skills on the post-test. They also found that gifted students scored significantly higher on the post-test than average achieving students who also received the intervention. The main contribution of this study, according to the researcher, was support for grouping high ability students with like-minded peers so that greater gains may be made in increasing the ability of gifted students to think critically.

Fisher's 2002 study examined fifth grade language arts teachers' teaching behaviors to note the frequency with which metacognition was modeled for students. Metacognition is a form of higher order thinking because awareness of one's thoughts demonstrates abstraction or conceptual thinking. The conceptual framework used for the study was Bloom's taxonomy. The sample included 20 fifth grade language arts teachers in the United Kingdom. Fisher observed these teachers for a total of 170 hours of instruction and involved them in focus groups as well in order to discern teacher conceptions of what makes good reading and writing and what role careful reflection plays in the processes of reading and writing. Fisher reported that in 170 hours of language arts instruction, only one instance of metacognition was modeled with the question, "Why do you think did the author began the sentence with and?" (Fisher, 2002, p. 53). A major contribution of this study highlighted the disconnect between what teachers feel they must teach, that is the *how* of reading and writing, versus the idea of *how one thinks about* concepts and themes inherent in language arts learning.

Paul & Elder (2004) investigated 66 American universities in order to assess critical teaching practices and knowledge of critical thinking among faculty teaching teacher preparation courses in California. The researchers also wanted to highlight exemplary teaching practices that enhance critical thinking and to develop recommendations based on their findings. Their conceptual framework was Paul's definition of critical thinking as well as the standards and intellectual traits he developed to support the elements of critical thinking.

Approximately 140 interviews consisting of both closed and open-ended questions were conducted. The interviews lasted approximately 45 minutes. The faculty

population was constructed in such a way that they were representative of faculty teaching in teacher preparation programs in California and that the results of the study were generalizable to teacher preparation faculty in the state.

Using an interview protocol developed specifically for this study, Paul discovered that although 89% of faculty members considered critical thinking to be an instructional objective, only 19% could articulate clearly a definition of critical thinking. Additionally, 78% of participants stated that their students are unable to assess their own thinking although they maintained that it is critical for students to be able to assess their own work. Of this 78%, only 8% could state what intellectual standards they required of their students. Half of the participants said that they could differentiate critical thinking skills from critical thinking traits, but only 8% could state which skills were important for their students to develop. Paul & Elder conducted a case-by-case analysis which revealed that most faculty have not carefully thought through a concept of critical thinking and are therefore unlikely to foster critical thinking in their students. This study's contributions were grounded in the fact that teacher preparation programs may be doing a disservice to pre-service teachers by neglecting to teach cohesive strategies for fostering critical thinking in the classroom.

One strategy which attempted to foster critical thinking in the science classroom was that of creating disequilibrium for students. Also known as cognitive conflict, this strategy was considered significant by instructors despite a lack of evidence on its worthiness (Zohar & Aharon-Kravetsky, 2005). These researchers attempted to discover under which circumstances, if any, cognitive conflict is an effective teaching strategy. The theoretical framework for this study stems from the work of Piaget who believed that

"when children's interactions with the world result in experiences that do not fit their current conceptions, their mental balance is disturbed" (Zohar & Aharon-Kravetsky, 2005, p. 829). Piaget purported that learning takes place when the balance is restored as a result of modifying or replacing children's conceptions.

From their literature review, Zohar and Aharon-Kravetsky determined that cognitive conflict may differ by student academic level as well as by teaching method. The researchers designed a study that took place with students of high ability in one setting and those of low ability in another. They used two distinct teaching strategies: creating a cognitive conflict and direct teaching with both groups of students.

The student sample consisted of 121 ninth grade students who were from 14 to 15 years of age. These students attended a large high school in a small town. The student population consists of students from a range of socio-economic backgrounds. Students are divided into two-tracks at the high school; they are either on a full- or partial-matriculation track. Full-matriculation means that the students are considered to be of high academic aptitude while partial-matriculation means that students are considered to have low academic aptitude. The division of students begins in eights grade, but the curriculum is the same for all students up to the end of ninth grade, regardless of how they have been tracked. The students in this sample study the same biology curriculum with the same teachers.

Two female biology teachers were responsible for teaching these sample students. One of these teachers had been teaching for two years when this study began; the second teacher had been teaching for six years.

Students were assessed three times during the course of the study. Students took a pre-test, a post-test, and a written test five months after instruction. Students were also interviewed and asked to perform higher order thinking tasks associated with science during the course of the interview. There were two instructional methods used in the study: direct teaching and inducing a cognitive conflict. The two methods shared certain elements such as activating prior knowledge, learning materials, learning environment, and time spent on task.

The researchers' findings confirmed their hypothesis that students of different levels respond to different teaching methods. Direct teaching resulted in higher gains for students of lower academic ability while inducing a cognitive conflict resulted in higher gains for students of higher academic ability. This was an important contribution to the literature in that it cautions educators to refrain from using a one-size-fits-all method of instruction in heterogeneous classes.

Giancarlo, Blohm, & Urdan (2004), researchers at Santa Clara University, report on the development of the California Measure of Mental Motivation (CM3), an instrument they designed because they feel that students who are capable of thinking critically in K-12 classrooms often choose not to do so. The CM3 measures "the degree to which an individual is cognitively engaged and mentally motivated toward intellectual activities that involve reasoning" (Giancarlo, et al., 2004, p. 349). Because previous studies involving dispositions or ""a person's internal motivation to think critically when faced with problems to solve, ideas to evaluate, or decisions to make" (Giancarlo, et al., 2004, p. 348) focused solely on postsecondary learners, the researchers chose to concentrate on middle and secondary school learners instead. Development of the CM3

was predicated on the notion that other instruments that determine motivation with respect to critical thinking are not suitable for the target population.

Instrumentation design took place over a two year period with a variety of populations. The initial population that tested the CM3 consisted of 1,378 students in grades 6 through 12 in 10 states. Nineteen schools were represented in the pilot population. Feedback forms were utilized outlining student and administrator experiences with the CM3. The second step of development involved validity and reliability studies. High school students in whole class settings representing a range of males and females as well as diversity with respect to ethnic backgrounds were tested.

The CM3 uses a Likert scale with 4-point scales ranging from *strongly agree* to *strongly disagree*. Initially 100 items were written with approximately half of those items written to be reverse-coded. An alpha factor analysis was used to derive four scales from the original 100 items. This was done to maximize reliability and so that the scales could be generalized across populations. Four subsequent studies were conducted to determine if the structure of the CM3 was in fact reliable and valid, as eventually 25 items were retained from the original 100 with overall reliability measuring at .83.

Findings of the four studies indicated that the CM3 is a reliable instrument to use with adolescent populations. The scales developed assess the extent to which students perceive themselves as willing and inclined to approach challenges in systematic ways. This was a valuable addition to the literature in that teachers have a method of determining whether lack of performance is equated to lack of ability of a lack of disposition to engage higher order thinking skills. Depending on the conclusion drawn

by the teacher, differentiated strategies could be used to enhance instruction for individual students.

Research studies involving critical thinking span a wide range of topics involving teaching and learning. All of these studies are grounded in the idea that critical thinking is vital for success, yet all differ markedly in how critical thinking should be taught as well as in how critical thinking skills are learned.

Background on Creative Thinking

Definitions of Creative Thinking

Definitions of creative thinking abound. Some scholars explicate creative thinking as ability, while others view it as an attitude. Still others consider creativity to be a process. Researchers have attempted to classify definitions of creativity into perspectives that highlight both the commonalities and differences between definitions, but they tend to disagree on whether to classify according to rational-irrational definitions or definitions reflecting theoretical perspectives in psychology (Coleman & Cross, 2001). Education, particularly the discipline of gifted education, is highly influenced by the work of J.P. Guilford who defined creativity as a malleable construct embodying fluency, flexibility, elaboration, and originality (VanTassel-Baska, 1998).

Some researchers view creativity as a component of gifted education (Passow, 1993) and attempt to include it in assessments of student eligibility for gifted services in the schools. Other researchers consider creativity to be a trait that overlaps with giftedness (VanTassel-Baska, 1998). Gagne (1995) defines creativity as an aptitude domain of giftedness, specifying that creativity "is a natural ability having a clear genetic origin" (p. 107). Another view researchers promulgate is that creativity exists merely as

a scaffold for supporting critical thinking (Runco, 1999), regardless of the fact that "creativity has been seen as the only uniquely 'human' characteristic, defining an area where, for instance, microelectronics cannot go" (Cropley, 1999). Despite the large body of creativity literature, there is a lack of consensus regarding a cohesive definition of creativity.

Nevertheless, researchers do agree on certain commonalities with respect to creativity. First, creativity requires the specialized use of knowledge (VanTassel-Baska, 1998; Cropley, 1999), although the "relative importance of particular factors is greater in some domains than others" (Cropley, 1999, p. 513). For example, the knowledge base needed for using tools may be very different in science as compared to the knowledge base required for using tools in art. However; creative individuals are able to invoke flexibility of thought by wielding their knowledge base in a manner which avoids "restricting it to the conventional" (Cropley, 1999, p. 516).

A second commonality upon which a majority of researchers agree is the creation of a novel product (Coleman & Cross, 2004; Cropley, 1999; VanTassel-Baska, 1998) as a "basis for comparison among people" (Coleman & Cross, 2004). Novelty, a component of creativity, must be coupled both with efficiency and relevancy, otherwise nonconformity ensues (Cropley, 1999). Useful novelty is considered innovation (Nickles, 2003), "a process by which the entrepreneur either creates new wealth producing resources or endows existing resources with enhanced potential for creating wealth" (Carayannis & Gonzalez, 2003, p. 592).

Characteristics of a Creative Thinker

Many researchers have compiled lists of characteristics of the creative thinker. Among them are Torrance (1969); Renzulli (1977); Amabile (1996); and VanTassel-Baska (1998). Several commonalities revealing the characteristics emerged upon examination of these lists. Similar items include independence or the ability to work autonomously; a high tolerance for ambiguity; openness to stimuli; a wide range of interests; task commitment or persistence in the face of frustration, and willingness to take risks. Nonconformist behaviors such as a willingness to take risks differ markedly from the more cognitive behaviors used to describe the critical thinker as previously discussed. Additionally, all four lists describe functional freedom in some form. Functional freedom may be defined as "the ability to use items for other creative or unique uses" (Carayannis & Gonzalez, 2003). Researchers note that overlap may occur between and among individual characteristics and "that not all of the traits need be present in any given individual or situation to produce a display" (Renzulli, 1997, p. 93) of creative behaviors.

A rich source of creative personality traits may be found by examining tests of creativity. There are at least 255 creativity tests available from which to choose (Cropley, 2000), and they purport to measure a wide range of creative products, processes, and individual characteristics. These tests take many forms ranging from games and riddles to problem solving scenarios to biographical inventories. Some tests measure adult creativity, while others are written to determine the presence of creativity in children. Cropley (2000) reviewed twenty such tests that defined creativity in a multi-faceted way and listed the elements found on each test under the headings of product,

process, motivation, and personality/abilities. Personality attributes which appeared to repeat over the different test forms, and are frequently used to identify not only creativity but giftedness as well, include an active imagination, flexibility, curiosity, independence, acceptance of one's own differences, tolerance for ambiguity, trust in one's own senses, openness to sub-conscious material, the ability to multi-task, the ability to restructure problems and to abstract from the concrete. Similarities between the characteristics on these tests closely mirrors the commonalities found between the lists compiled by the researchers discussed previously.

Development of Creativity

Developmental psychology attempts to "understand the stages in the development of a creative person" (Piirto, 2004). Creative development has been described as "an increase in creative functioning over time with unspecific attention to promoting growth. . . [as well as] increased competence with specific organized efforts to develop it" (Coleman & Cross, 2001, p. 267). These disparate concerns attempt to evidence creative growth throughout an indeterminate time span. If creativity is a result of unspecific attention to promoting growth, then Goswami's *Quantum Theory of Creativity*, which purports unconscious processing, implies that possibility is and has been a major factor in creative discoveries throughout history (Goswami, 1999).

Other scholars present creativity as an attribute which extends across one's lifetime and is directly attributable to childhood curiosity (Coleman & Cross, 2001). Childhood curiosity may be ascribed to nuance, "a special kind of sensitivity to the universe" (Goswami, 1999), while others assign experience a greater role in the development of creative potential (Runco, 1999).

The intent to create becomes questionable when comparing creativity across developmental stages. "Children's creativity may be unintentional . . . their originality may appear to be accidental" (Runco, 1999, p. 539), whereas adult creativity may be rife with purpose. Perspective between child and adult may be skewed as "what is original to a child may not be original to an adult" (Runco, 1999, p. 539). Extreme cases of creativity—those which occurred before age 10—have been held as examples of intense cases of rapid human development with respect to creativity in order that the idiosyncratic might shed light on more typical occurrences of creative thinking (Piirto, 2004).

Teaching Creativity

In their behaviorist approach to creativity, Epstein & Laptosky (1999) described research studies that determined that specific descriptive praise evoked creative behavior in preschool children. Similar studies conducted with third, fourth, and fifth grade students over a period of six years yielded the information that reinforcement, such as praise or positive feedback, induced creativity. Over time, research conducted at the secondary and college levels revealed similar information (Epstein & Laptosky, 1999).

Many of these behaviorist studies were conducted during the 1970s and 1980s. More recent research suggested that "reinforcement produces behavior that is repetitive and uncreative" (Epstein & Laptosky, 1999, p. 179) and "can interfere with artistic creativity" (Amabile, 1979). It is suggested by Epstein & Laptosky (1999) that reinforcement only interferes with creativity if used improperly, that is, giving praise or positive feedback that is unmerited results in trivial behavior and below standard

products, implying that practitioners should exercise sincerity when using praise as reinforcement.

Runco (1999) reported on two types of classifications of promoting creative behaviors, the "let-it-happen" tactics and the "make-it-happen" tactics, both of which he attributed to the work of Sidney Parnes. *Let-it-happen* strategies require some form of relaxation, while *make-it happen* tactics need focused cognitive processing. An example of a *let-it-happen* tactic might include incubation, while a *make-it-happen* tactic might consist of borrowing or adapting from an extant idea or concept (Runco, 1999). Implications for practitioners when considering these sorts of tactics include allowing for sufficient amounts of time to allow students to successfully utilize such strategies.

Interpersonal tactics can facilitate creative thinking as well (Runco, 1999). Cooperative learning, brainstorming, debating, and arguing a perspective not one's own are examples of interpersonal strategies. These tactics are particularly valued because they promote the "active exchange of ideas within small groups" (Gokhale, 2005) as well as a common goal. The additional value of using interpersonal strategies to promote creativity in the classroom lies in the fact that they mimic real-world, information-rich thinking tasks when they are grounded in real-world contexts (Halpern, 1998).

Relevant Creative Thinking Literature

Students and Creative Thinking

In 1993, Delcourt undertook a qualitative study to determine what factors are associated with creative/productive behavior in secondary school students and if the factors associated with these students could be found across cases. Delcourt drew upon a large body of creativity literature in which to ground her study. She used the work of

Goertzel, MacKinnon, Sternberg, and Walberg as well as Torrance and Milgram. Each of these authors investigated different aspects of creativity, but Delcourt used their work to show that students can impact the larger community through production of creative products and that creative behaviors should match programming offered in schools.

The sample for this study consisted of 18 students in grades nine through twelve at four different schools that are associated with gifted education. The schools were situated in three states. Eight participants were female and ten were males. One participant was in the ninth grade, two were in tenth grade, ten were in eleventh grade, and one was in fifth grade.

Data sources included two parent questionnaires: one which detailed family background and the other which probed the quantity and quality of student projects completed within and outside of the school environment. Information concerning interest and effort was also explored. Students participated in 2 hour taped interviews. Interview questions concerned family background, educational experience, and perception of project development. *A Self-Appraisal Inventory (Measures of Self-Concept K-12*, 1972) was administered to all participants as was a *School Sentiment Index (Attitudes Toward School*, 1972) for high school students.

Findings included the fact that student creativity with respect to processes and products varied with level and intensity according to the task selected and to individual differences among students with respect to their developmental level. Most students seemed to be developing products which rendered self-satisfaction. Delcourt's findings emphasized that students feel that their creative products need to be shared. The contributions of these findings included the fact that student creative products need to be

assessed with sensitivity and that effort should be made by educators to find a wide variety of audiences so that students may exhibit their creative projects.

Wolfratz & Pretz (2001) researched the idea of creativity and individual differences with respect to personality in their study among college students. These researchers used a large body of creativity literature dating from 1985 to provide evidence of a positive relationship between personality and creativity. Woflratz & Pretz (2001) investigated creativity and personality in the hopes that they could broaden the definition of the creative personality.

The sample included 204 students from the University of Halle as well as the College of Art Design in Halle, Germany. The sample consisted of 112 female students and 92 male students spanning 18 to 44 years of age. Student fields of major included psychology, art and design, sciences such as physics and chemistry and medicine, sociology and literature. All students volunteered to participate in the study.

Three methods were used to measure creativity of these students. First the Creative Personality Scale (CPS) (Gough, 1979) was administered to each student. The scale consists of 30 items which ask students to rate themselves on a variety of creative characteristics. Participants were then asked to write a story about a picture using their imagination. The third method of creativity involved asking the participants to provide researchers with a list of their hobbies in an attempt to assess participants' natural interests and creative activities in the real world.

The study's results indicated support for the relationship between personality and different types of creativity. Openness to experience positively related to all three methods discussed above. Extraversion was also positively related to creativity,

supporting previous research on the same topic. The researcher found a higher level of both story and hobby creativity in females than in males. The study's contributions for educators may include tailoring tasks and assignments to fit personality styles so that creativity may be optimized.

Jones' 2002 study was concerned with identifying creative behaviors in young school aged children. The research was interested in learning how creative thinking developed in these young children over the course of the school year as well as how the development compared to scores on the Torrance Test of Creative Thinking.

The theoretical framework used for the study was the Community of Enquiry format. Based on Matthew Lipman's Philosophy for Children program, which encourages children to think critically, creatively, and democratically through dialog, the Community of Enquiry utilizes children's literature as a basis for discussion. Picture books are the most common stimulus used in the Community of Enquiry with students this young. The Community of Enquiry is similar to the Junior Great Books program in the United States in that the teacher serves as facilitator and a piece of literature serves as the starting point for discussion.

The sample for the study included nineteen children in a mixed-age classroom of school year one and two in Northumberland, United Kingdom. All participants spoke English as their first language. The students attended a small village school in rural Northumberland whose total population was approximately 50 students. The school recorded approximately 5% of the population as eligible to receive free meals.

Both qualitative and quantitative data were generated during this study. The qualitative data consisted of observational notes recorded during Community of Enquiry

sessions. Children's opinions of sessions were gathered via self-assessment sheets and interviews. Qualitative data were generated from a pre- and post-administration of the Torrance Tests of Creative Thinking and 17 Community of Enquiry sessions which were recorded and transcribed. Axial codes were reviewed by the researcher's supervisor to bolster reliability of coding.

Findings included increases in novel thinking and reflexive thinking over the course of the year. Most children (85%) were reported as having taken an active role in discussions by the end of the year as compared to the 61% who were willing to participate at the beginning of the year. Only one child made fewer responses expressing novelty in the second half of the year. More novel responses to stimuli were offered by males than by females. With respect to the Torrance pre- and post-measures, 17 of the 19 students saw significant increase in scores, while only two student scores decreased.

This study's contribution lies with encouraging creative expression in very young children as an enhancer for fostering creativity among older students. Additionally, this research supported the notion that a safe learning community is one in which young children feel able to take risks and display creative behaviors.

Newman (2005) examined whether or not teachers can design creative learning experiences that emphasize integrating higher order thinking processes through the production of creative products. She noted that students involved in Renzulli's Schoolwide Enrichment Model (Renzulli & Reis, 2002) often fail to finish their creative products. Therefore, Newman investigated the effects of the Talents Unlimited model on the completion rate of student products as well as on the quality of these products.

The theoretical framework of the Talents Unlimited Model (Taylor, 1986) is designed to improve student critical and creative thinking using classroom curriculum. The Model targets the thought processes of: Productive Thinking, Communication, Forecasting, Decision Making, and Planning. Academic talent is the framework for these thought processes.

The participants for the study consisted of 104 third through sixth grade students that participated in enrichment programs. These students attended nine schools in three different school districts but were selected for their similar socioeconomic, curriculum and staff characteristics. The treatment group was constructed of 59 students who completed 27 projects either individually or in small groups and the control group was made up of 45 students who also completed 27 projects. Ten enrichment teachers involved in the study had training in the Talents Unlimited Model as well as Renzulli's Schoolwide Enrichment Model. Teachers were randomly assigned to teach the Talents Unlimited Model. Teachers of both groups were encouraged to ask their students to provide quality creative products.

A post-test only control group research design was used in this study. Students in the experimental group were given structured lessons that applied the Talents Unlimited Model to investigating real-world products. A chi-square analysis was used to analyze data regarding the completion rate of products. Analysis of Variance (ANOVA) was used to determine the quality of products between and within groups. Open-ended questionnaires were administered to students and teachers in the treatment group so that elaboration on and evaluation of the creative process could occur.

Findings indicated that the Talents Unlimited Model served to increase student completion of creative products better than when students were not using this model. Students considered themselves better equipped to identify projects which were interesting to them as well as to focus on the chosen topic for study. Students in the treatment group self-reported increased quality in their products as well. The self-reports were bolstered by statistical data showing that the experimental group significantly outperformed the comparison group.

The study's contributions included support for the fact that when students consider projects worthwhile, products will be completed with a high level of quality. The Talents Unlimited Model may help students better identify projects on which they will be successful, which hold meaning for them, and on which they can sustain focus for longer periods of time.

Teachers and Creative Thinking

Beginning in 1958, Paul Torrance began examining research that predicted the adolescent and adult creative behavior of students who were considered creative while still in elementary school. His initial findings were published in 1981 and later revised. In 1964 all students in two schools were administered various subtests of the Torrance Tests of Creative thinking annually. Scores over a three year period were averaged to yield a Creativity Index. In 1980, follow-up behaviors were obtained from 220 of the original 400 subjects. Reports on follow-up behaviors were obtained from 118 females and 102 males. Five indexes of creative behavior were delineated from questionnaire responses to include: number of high school creative achievements; number of post-high school creative achievements; number of creative life style achievements; ratings of the

quality of highest creative achievement described; and ratings of the creative quality of the aspirations and future images described (Torrance, 2004). In sum, Torrance discovered that measures of intelligence were only marginally related to creativity, while having experienced living in a foreign land contributed to creative achievement measures, and having had a mentor was related significantly to creative achievement. This study is one of the few longitudinal studies of creativity available to researchers and scholars. Its contribution as a longitudinal study of creativity cannot be understated, particularly when participants are asked for qualitative data regarding their perceptions of teachers who made a difference and who evoked creativity in their students. As of 2004, questionnaire data were still being assembled for publication.

Kolloff & Feldhusen (1984) maintained that results of creativity studies are generally positive and that creative thinking abilities can be increased through systematic training. These researchers investigated whether the effects of an enrichment program based on the Purdue Three-Stage Model would increase the self-concept and creative thinking abilities of gifted elementary students. Eight elementary schools in Indiana were chosen from which to garner a sample of participants. Participants included third, fourth, and fifth graders who were selected by achievement test scores and teacher ratings of giftedness. Selected participants included the top 420 students on these measures. The participants were randomly assigned to an experimental or control group. They participated in a pull-out program which was instructed by a trained resource teacher.

The pull-out program, Program for Academic and Creative Enrichment (PACE) was based on the Purdue Three-Stage Model for Gifted Education. The program's goal included developing creative thinking skills and other higher order thinking skills,

research skills, and developing positive self-concept through interaction with like-minded students. Students were presented with a broad range of activities which gave them a foundation in thinking skills. They then transitioned to activities which enabled them to apply these skills to various scenarios such as school problems, home problems, local and community problems and national and international problems. After this stage, students transitioned to researching topics of interest independently.

Data were collected after the administration of two self-concept scales: the Piers-Harris and the ME Scale and four scores on the Wallach-Kogan Creativity Instrument which measures verbal fluency, originality, figural flexibility, and figural originality.

Findings indicated that gifted programs do not affect self-concept either positively or negatively as a result of an analysis of the Piers-Harris and the ME Scales. However, the PACE program did seem to enrich creative thinking ability as students who received the PACE treatment scored significantly higher on the Wallach-Kogan Creativity Instrument. This study's contributions gave support to the notion that targeted creativity training can increase creative productivity and that gifted students achieve significantly when grouped with students of similar abilities.

Kennedy's 2002 study utilized an undergraduate music course to determine the potential of music composition as a vehicle for introducing creative activities into K-12 classrooms. The theoretical foundation for her work is grounded in a rich body of literature on music and creativity including the work of Byrne, Cohen, King, Morin, and Sullivan "who address matters of creative pedagogy" (Kennedy, 2004, p.32).

Kennedy's sample consisted of nine undergraduate pre-service teachers all of whom were enrolled in a regular undergraduate music education course. Seven of the

participants were female, two were male. Assignments were designed to mirror activities which took place in K-12 classrooms and were either assigned as individual projects or group work. Data were collected through observation, informal conversations with students, and document analysis. Document analysis took the form of material culture which included five sets of reflective journals, student scores and/or recorded versions of their songs, recorded versions of two musical electronic projects, written evaluations of a program piece, a process video of a song writing project, and student peer evaluations of the electronic musical products.

The study's design mimicked that of an action research model. Action research is described as "practical, directed at the researcher's own concerns and, for those who wish, a tool to bring about social or educational change" (Kennedy, 2002, p. 35). Kennedy considered her role not only as a researcher but as a complete participant in the study.

Kennedy's findings noted that the creativity component of assignments "paralleled the creative process itself by taking on a life of its own" (Kennedy, 2002, p. 35). Examples of the creative process included students asking to write their own lyric and music instead of completing a variation project and another student composing a piece for piano instead of using a synthesizer and voice as was recommended by the professor. Changes were accepted in project assignment without penalty to the student. Other results that were consistent across projects included varying amounts of incubation time, depending upon the way in which a student approached a task. Additionally, students demonstrated more fluency and relaxation with subsequent tasks. Kennedy

attributed this finding to the development of an atmosphere of trust between students, even during the peer review process.

This study's contributions focused on the idea that in order to teach creativity, one must have experienced the creative process. By designing the undergraduate course to mirror activities which take place in K-12 setting, Kennedy established the conditions under which K-12 students work for her undergraduate pre-service teachers. The study's participants reported that being in a flexible, accepting environment allowed them to create and feel uninhibited in ways that they had not experienced in previous courses they had taken.

Hamza & Griffith's 2006 study examined exemplary teaching practices, namely those that engendered creative thinking in university classrooms. The theoretical framework which grounded this study comes from educational psychology and business literature which maintains that "numerous educational, teaching, and academic factors greatly influence a student's future learning and future productivity in the career workplace" (Hamza & Griffith, 2006, p. 2). Creative thinking was considered by these researchers to be a skill which will enable students "to survive a tough and competitive "real" world" (Hamza & Griffith, 2006, p.2) and so were determined to tease out those exemplary instructional approaches of college professors who nurture creative thinking.

The study's sample consisted of faculty members at a state college in Texas. Professors were selected by a complex process in which students were the primary source in identifying a purposive sample of teachers. Teacher interviews, creative thinking checklists, and student response forms assisted the process of formulating a participant pool. Neither part-time faculty nor adjunct faculty was considered for the study.

The study's design was qualitative and naturalistic. Data collection, data analysis, member checking, and emergent themes established authenticity in the study. Classroom observations, informal interviews, teacher interviews, surveys of student attitudes created short case studies which became the primary data source for the study. Data were analyzed according to guidelines of naturalistic inquiry by categorizing, coding and comparing data to determine the existence of emergent themes.

The study's findings indicated that exemplary teachers who foster creative thinking in the classroom share common qualities. Among these qualities are: the ability to learn from both failures and successes; the quality of having a strong passion for what they do; the ability to draw on prior experiences, however disparate those experiences may seem; caring about student successes and failures; experiencing life from a perspective all their own; high interest in the subject they teach; having general knowledge of a broad range of topics and fields; the ability to use analysis and synthesis in decision making; creating unique, novel methods of teaching. This study contributed to the literature by targeting those characteristics that are not only highly desirable in good teachers, but in creative teachers as well. Fostering these qualities in pre-service teachers will enable more students to become equipped to face challenges in the global marketplace.

Relevant Professional Development Literature

Because the scope of this exploratory study sought to determine the effect to which teacher inputs affect teaching critical and creative thinking, specific literature on the importance of teacher inputs must be mentioned. The discussion of this literature is

not meant to reflect a comprehensive literature review, but exists rather to set the stage as a major backdrop to the study.

Methods of linking student achievement with teacher quality are just beginning to emerge from quantitative studies that examine the factors of teaching that lead to increases in student achievement. The most significant of these studies to date, *How Teaching Matters: Bringing the Classroom Back Into Discussions of Teacher Quality* was conducted by Harold Wenglinsky at the Policy Information Center with funding from Educational Testing Service and the Milken Family Foundation. Wenglinsky's conclusions indicate that there is a specific methodology to improving teacher effectiveness through improved classroom practice.

Wenglinsky's results include three distinctive domains of teaching and learning: improving teacher inputs, professional development, and classroom practice. Because teacher input information holds potential significance for this study's findings, Wenglinsky's definition of teacher inputs was adopted. The definition of teacher inputs includes level of education, major, number of years teaching, number of days of professional development received in the last year in various categories, and types of assessment used in the classroom. (Wenglinsky, 2000).

What Makes Professional Development Effective?

In 2003, Thomas Guskey of the University of Kentucky analyzed thirteen lists concerned with the characteristics of effective professional development. Derived from a variety of sources, the lists were intended "to guide school leaders in their improvement efforts" (Guskey, 2003, ¶ 1). Most of the lists included the same elements or characteristics, but agreement about the characteristics of effective professional

development was inconsistent across the lists. Additionally, the characteristics that appear on most of the lists were largely generated from survey responses, rendering the results less objective in their derivation.

Eleven of the thirteen lists show that professional development activities should "enhance teachers' content and pedagogic knowledge" (Guskey, 2003, Results Section, ¶ 1). This characteristic supports the National Board for Professional Teaching Standards (NBPTS) standard that states "teachers know the subjects they teach and how to teach those subjects to students" (NBPTS, 2004, *Backgrounder*, ¶13). Others contend that enhancing teachers' content and pedagogic knowledge is an ill-defined professional development goal. Ball & Cohen (1999) agree that teachers' knowledge of content is important, but that it is equally important to understand and be able to convey "meanings and connections" (p. 7) rather than simply relying on "procedures and information" (p. 7).

A demand for adequate time and resources for educators was included as a necessary characteristic of effective professional development on ten of the lists (Guskey, 2003, Results Section, ¶5). Extra time for teacher education is often largely viewed as "something done after or apart from regular teaching responsibilities" (Little, 1999, p. 243) rather than as an integral part of teaching practice.

There are two discrete factions regarding the topic of additional time for educators' professional development. One side, as reported by Wenglinsky (2000), maintains that "the amount of time is not significantly related to achievement (p. 7). Wenglinsky's results are echoed by Kennedy (1998) whose research failed to forge a link between time spent on teacher professional development and student achievement. Since

both studies were concerned distinctly with teacher development and mathematics instruction, however, the results may be specific to that field. The opposite argument declares that time for teacher professional development and student achievement are inexorably linked. Novick (1996, p.5) contends that it is imperative for teachers to have "time for observation, reading, reflection, dialogue with colleagues, and support for these practices at the district, state, and federal levels." Other researchers (Fullan, 1993; Guskey, 1995) agree that professional development must be continuous and supported in terms of both time and resources.

An additional common characteristic among the thirteen lists was the presence of collegiality and collaboration (Guskey, 2003, Results Section, ¶6). Hawley & Valli (1999) maintain that collaboration within the school supports problem solving, creates a sense of community, and dispenses with teacher isolation. Novik (2004) identifies collaboration as an entity which should not only occur within the school. She cites teacher networks and collaboration with early care and education providers as viable sources of collegiality and collaboration that ultimately result in both teacher and student learning.

Another characteristic common to most lists was the presence of specific evaluation procedures. Guskey (2003, Results Section, ¶7) attributes the inclusion of this particular characteristic as a response to the current climate of reform in which accountability is stressed. Sykes (1999) suggests that tying "both formative and summative evaluation of Teacher Professional Development" (p. 169) is a viable method by which schools and districts can create a firm accountability system. Little (1999) adds more non-traditional forms of teacher assessment such as the portfolio and examination-

based methods of the National Board for Professional Teaching Standards and peer review as useful and reflective of classroom practices.

Keeping professional development activities within the school was another characteristic of Guskey's (2003, Results Section, ¶9) lists. Hawley & Valli (1999) agree that professional development should be both "school-based and integral to school operations" (p. 140). These researchers contend that although out of school events are worthy, school-based activity is often overlooked as one of the most powerful forms of professional development (Hawley & Valli, 1999). A transformation of school as a workplace to a place from which adult learning arises is indeed a powerful metaphor.

Guskey (2003, Results Section, ¶11) notes two factors of the compiled characteristics that are somewhat surprising. First, few of the lists stressed using student learning data to drive teacher professional development. This lapse clearly weakens an attempt to link professional development with student achievement. Secondly, none of the lists included involving families and other stakeholders in teacher professional development events.

Tailored Professional Development

"Every person develops and uses a mixture of learning styles throughout life, usually flexing and adapting styles to fit various contexts and to meet a variety of learning demands" (Silver, Strong, & Perini, 2000, p. 29). The implication inherent in this statement is that learning is a lifelong process with demands dependent upon context. The statement and its implications are important considerations when planning and designing professional development for educators.

Teacher as learner is a neglected characteristic of the educational professional development arena. The characteristics of content knowledge, time, resources, collegiality, collaboration, evaluation procedures, and context took precedence in Guskey's (2003) lists. Even the unlisted components, data and stakeholders, outweighed the importance of the teacher as a learner. While teacher as learner may be implicitly understood by professional development facilitators, it is imperative to highlight this domain when new professional development opportunities are planned and designed.

Teacher learning involves a measure of discomfort. Optimal learning, according to Vygotsky (1978), involves a pitching the level of instruction above an individual's comfort level. In order to do so, professional development facilitators must incorporate scanning of their participants' prior experiences into professional development events so that they can direct learning experiences accordingly. Doing so will ultimately create the mental state called "flow" (Csikszentmihalyi, 1990) during which favorable learning conditions are fostered.

Such ideas are supported by Reitzug's (n.d.) work at the University of North Carolina, Greensboro. His recommendations for professional development include "clear articulation of the relationship between teacher growth and professional development" (Reitzug, n.d., Recommendations Section, ¶4).

Summary of the Literature

In summary, relevant strands of literature reviewed provide a foundation for this study in examining the importance of critical and creative thinking as two higher order thinking skills that are relevant to the field of gifted education but also central to student life-long learning. An examination of the definitions of both critical and creative

thinking reveal disagreement about the nature of these constructs. Furthermore, the characteristics inherent in the ideal critical and creative thinker closely mirror characteristics sought when identifying for giftedness.

Policy makers and scholars agree that higher order thinking skills should be addressed in America's schools, yet the literature reveals a gap between policy and practice. Isolated pockets of teachers who practice teaching critical and creative thinking at all levels exist; however, lack of cohesive standards and faculty understanding of these thinking skills yields little in perpetuating a nation of educating critical and creative thinkers. A brief examination of relevant professional development literature suggests that scrutinizing teacher inputs may reveal areas by which targeted professional development may clarify definitions and enable researchers to render cohesion with respect to the teaching of higher order thinking skills.

Table 1

Selected Critical Thinking Literature

Theme	Source	Summary
Students & Critical Thinking	Gierl, 1997	Students select levels of Bloom's taxonomy according to task.
	Burbach, 2004; Ching & Chaun, 2004; Clements & Burns, 2000; Jackson, 2000; Yehudit & Revital, 2000	Higher order thinking skills can be improved.
Teachers & Critical Thinking	Lang, 2001; Roberts, Ingram, & Harris, 1992	Teachers' critical thinking skills can be improved.
	Fisher, 2002	Metacognition is a strategy that is missing from instruction
	Paul & Elder, 2004	Faculty cannot define critical thinking.
	Giancarlo, Blohm, Urdan, 2004	Secondary students' dispositions toward critical thinking are measurable.
	Zohar & Kravetsky, 2005	Differences between teaching through cognitive conflict and direct teaching.

Table 2

Selected Creative Thinking Literature

Theme	Source	Summary
Students & Creative Thinking	Delacourt, 1993; Newman, 2005	Creativity is dependent upon developmental level and individual differences.
	Wolfradt & Peetz, 2001	The relationship between critical and creative thinking is ill-defined.
	Jones, 2002	Creativity should be fostered at an early age.
Teaching & Creative Thinking	Torrance, 1981	Intelligence and creativity are separate constructs.
	Kolloff & Feldhusen, 1984	Creativity training can increase creative productivity.
	Hamza & Griffith, 2006; Kennedy, 2004	Experience with the creative process promotes a better understanding of the process.

Table 3

Selected Professional Development Literature

Theme	Source	Summary
Professional Development	Kennedy, 1998	Professional development helps teachers foster open-ended responses in the classroom.
	Ball & Cohen, 1999	Professional development is most effective when centered on developing practice and practitioners.
	Sykes, 1999	Teacher learning is an important component of professional development.
	Little, 1999; Wenglinsky, 2000	Active professional development is superior to more traditional forms.
	Hawley & Valli, 1999	School-based professional development is a powerful tool.
	Guskey, 2000; 2003; Reitzug, n.d.	Common characteristics include duration, collegiality, and resources; change in teacher attitudes happens after student achievement increases from changes in classroom practice.

Chapter 3
Methodology

Introduction

This study concerns teacher employment of higher order thinking skills, namely critical and creative thinking, among elementary language arts teachers involved in a federal research grant designed to scale-up language arts instruction for high-ability learners of minority populations called Project Athena. The importance of teaching higher order thinking skills has been cited by the research as imperative for American students and forms the context of this proposed study. In this study, data were collected regarding teacher inputs or background information as defined by Wenglinsky (2000), teacher ability to think critically and creatively as determined by valid and reliable measures, and teacher interpretations regarding critical and creative thinking in their classrooms as revealed by themes that emerged during the interview process.

This chapter presents the research methodology for the study and is divided into the following sections: (a) the research questions; (b); description of the methodology; (c) a description of the sample; (d) description of the instrumentation; (e) procedures for the study; (f) data analysis procedures; (g) a statement of bias; and (h) limitations and delimitations.

The Research Questions

The following research questions guided the study:

1. Are there differences between experimental and comparison teachers participating in Project Athena with respect to training and experience in teaching critical thinking and other inputs of advanced learning that might affect the use of higher order thinking skills?

2. What differences are there between experimental and comparison teachers participating in Project Athena on tests of critical and creative thinking?

3. What differences exist among Project Athena teachers on a test of creative thinking?

4. How do these Project Athena experimental and comparison teachers define critical and creative thinking?

5. How are critical thinking activities employed in these classrooms? Do they vary between experimental and comparison teachers?

Description of the Study

Teacher participants in Project Athena, whether defined as experimental teachers or comparison teachers (N=60), were asked to participate in this study. Additionally, the researcher examined Classroom Observation Scale-Revised (COS-R) data from Years 1 and 2 of Project Athena implementation at the teacher level. Those teachers who scored 2.5- 3.0 (Effective) on the sub-scales of critical and creative thinking were selected as potential participants for interviews.

The teacher participants were administered the Watson-Glaser Critical Thinking Appraisal (WGCTA)-Form S as well as the Abbreviated Torrance Test for Adults (ATTA). The WGCTA is designed to measure critical thinking skills by asking "the examinee to evaluate reading passages that include problems, statements, arguments, and

interpretations" (Harcourt Assessment, Inc., 2006). A subscale for inference, recognition of assumptions, deductions, interpretation, and evaluation of arguments is part of the WGCTA. This subscale aligns well with Paul's reasoning model that is used in the William and Mary Language Arts for High-Ability Learners curriculum units and measured on the COS-R. The ATTA is an abbreviated form of the Torrance Tests of Creative Thinking (TTCT) which has longitudinal data that evidences "a strong relationship between test behavior and real-life creative achievement" (Goff & Torrance, 2002, p. 1). The rationale for the abbreviated form is the same as for the original test, namely to identify a variety of abilities that seem to be important in producing creative responses (Goff & Torrance, 2002).

In addition to the administration of the measures cited above, each teacher who scored 2.5-3.0 (Effective) on the COS-R subscales of critical and creative thinking was asked to participate in an hour long interview to probe her definition of critical and creative thinking as well as the activities used in the classroom designed to promote these higher order thinking strategies. The protocol used by Richard Paul in his study of *California Teacher Preparation for Instruction in Critical Thinking: Research Findings and Policy Recommendations* (Paul, Elder & Bartell, 1997) was selected for use in the interviews. The interview protocol may be found in Appendix D. In addition to the interview protocol, Paul's coding sheet for open-ended questions was utilized as well. Because the coding sheet was concerned solely with matching participant responses to specific critical thinking skills and definitions, interviews were also examined for emergent themes. A sample coding sheet may be found in Appendix E.

Description of the Sample

The sample consists of those teachers who participated in Project Athena during Implementation Year 3 (2005-2006). The sample consisted of 60 teachers. Demographic data on the teachers was collected at the onset of Project Athena or whenever new teachers were admitted to the program due to teacher migration. All teachers selected for the sample are white with the majority falling between 41-50 years of age. Twenty-four teachers agreed to take the Watson-Glaser Critical Thinking Assessment-Form S and the Abbreviated Torrance Test for Adults.

The study's sub-sample consists of those teachers who were selected for interviews. These teachers scored 2.5-3.0 (Effective) on the Implementation Year 1 and Year 2 COS-R subscales for critical and creative thinking. This sub-sample consisted of 10 experimental and 7 comparison teachers at the third, fourth, and fifth grades. Experimental teachers are those teachers who implemented the William and Mary Language Arts Curriculum for High-Ability Learners, while comparison teachers are those teachers who taught district-based language arts curriculum. Seven of these teachers agreed to be interviewed.

The majority of teachers in the selected sample have been teaching for more than ten but less than 20 years. Of the twenty-four teachers selected for the sample, 8 reported earning bachelor's degrees, while 7 have achieved a master's degree. It is assumed that those who did not report (N=9) with respect to degrees have a bachelor's degree in order to meet the minimum requirement for a teaching license in the state in which the research study was conducted. Only two teachers report having majored in language arts in college and only three have advanced training or certification in gifted education. Nine

of these teachers have more than six years on grade level, eight have taught at their present school for more than five years, and ten have remained in the same school district for over five years. Twelve teachers from the proposed sample agreed to be interviewed. Available demographic data are summarized in the table below.

Table 4: Available Demographic Data

Age	< 30 years	31-40 years	41-50 years	51-60 years
	3	5	4	0
Race/Ethnicity	White	African American	Hispanic	Asian American
	12	0	0	0
# Years Teaching Experience	1-5 years	6-10 years	11-20 years	> 20 years
	4	6	2	0
# Years Teaching Language Arts	1-5 years	6-10 years	11-20 years	> 20 years
	4	4	4	0
# Years at Current Grade Level	1-5 years	6-10 years	11-20 years	> 20 years
	6	4	2	0
# Years at Current School	1-5 years	6-10 years	11-20 years	> 20 years
	6	5	1	0
Highest Degree Earned	Bachelor's	Master's	Doctorate	
	8	4	0	
Undergraduate Content Major	Language Arts	Mathematics	Science	Social Studies
	2	0	0	0
Advanced Degree in Gifted Education?	Yes	No		
	3	9		
# Course Credits in Gifted Education	0-5	6-10	11-20	>20
	9	3	0	0

Description of the Instrumentation

Instrumentation used in this study included the Watson-Glaser Critical Thinking Appraisal (WGCTA)-Form S (Appendix A), the Abbreviated Torrance Test for Adults (ATTA) (Appendix B); a Wenglinsky Questionnaire (Appendix C); the Interview Protocol (Appendix D), and an interview coding sheet (Appendix E).

Watson-Glaser Critical Thinking Appraisal (WGCTA)-Form S

The Watson-Glaser Critical Thinking Appraisal (WGCTA) - Form S, found in Appendix A, is an abbreviated form of the Watson-Glaser Critical Thinking Appraisal. The WGCTA-Form S consists of 40 multiple-choice items, with item options ranging from 2 to 5, and can be completed in 30 minutes. Respondents are provided with five scenarios and asked to judge possible conclusions to given situations. The scenarios provide scores for five subtests ranging from 0 to 40. The five subtests include: (a) making inferences; (b) recognizing assumptions; (c) making deductions; (d) interpreting evidence; and (e) evaluating arguments. The match between these subtests and the critical thinking subscales on the COS-R is readily apparent. For example, where the COS-R determines teacher encouragement of judging or evaluating situations, problems, or issues, the WGCTA evaluates making inferences and recognizing assumptions. Similarly, the COS-R seeks evidence of student engagement in comparing and contrasting ideas, while the WGCTA-Form S provides participants opportunities to evaluate arguments. Where the COS-R seeks out behaviors which foster generalizations from the concrete to the abstract, the WGCTA-Form S determines whether examinees can make deduction and inferences and interpret evidence.

The WGCTA-Form S's total Critical Thinking Score is compiled from the five subtests. The internal consistency for the WGCTA-Form S, as reported by the test manual, is .81, falling within the range suggested by Bracken (1993, 1996) as yielding reliable data. Studies investigating whether the WGCTA-Form S is a reliable and valid instrument to measure critical thinking (Gadzella, 2005), determine it to be so, particularly for measuring critical thinking in those students who are pursuing a teaching career. Additionally, high scores on the WGCTA-Form S were positively correlated with high grades in education classes, therefore it is expected that teachers with effective scores, scores in the 2.5 to 3.0 range, on the critical thinking subscale of the COS-R will score above the fiftieth percentile on the WGCTA-Form S.

Abbreviated Torrance Test for Adults

Assessing creativity is problematic due to the lack of a cohesive definition of the construct. Of the plethora of creativity tests available, the Abbreviated Torrance Test for Adults (ATTA) was chosen for this study due to repeated longitudinal studies connecting test behavior with real-life creative ability (Goff & Torrance, 2002) as well as the benefits derived from a shortened testing time. The ATTA consists of three activities, each of which must be accomplished within a three-minute time limit. Adhering to the precise time limit allows for correlation with normative-based interpretations of responses. (Goff & Torrance, 2002).

The ATTA's three activities are constructed to measure four norm-referenced abilities: fluency or the ability to produce quantities of ideas relevant to the task; originality or the ability to produce uncommon and/or unique ideas; elaboration or the ability to add detail to one's ideas; and flexibility or the ability to manipulate ideas in a

variety of ways within the criteria of the same task (Goff & Torrance, 2002). The creativity indicators for the three tasks are designed to generate both verbal and figural responses. The ATTA tasks compare positively with COS-R subscale items involving creative thinking. The COS-R identifies teacher behaviors which solicit diverse thoughts about issues or ideas, the reframing of ideas, demonstrations of open-mindedness and tolerance of imagination and humor, as well as providing opportunities for elaboration of ideas.

Norm-referenced measurement involves "the interpretation of an individual's test score by comparing it to the scores earned by other individuals" (Gall, Gall, & Borg, 2003, p. 204). The norm-referenced items on the ATTA probe fluency, originality, elaboration, and flexibility as defined above. The score used for individual abilities is a 9-point scale, with potential values of 11 through 19, and 15 being average or the middle 20% of respondents (Goff & Torrance, 2002). Scaled scores of 16 or higher are considered above average while scores of 14 and below are considered in the below average range. Since the same scale is used for each of the four creative abilities, direct comparisons can be made across the abilities (Goff & Torrance, 2002). It is expected that teachers scoring high on the creative thinking subscale of the COS-R will score at 15 or above on the norm references items of the ATTA.

There are 15 criterion-referenced indicators on the ATTA, five of which induce verbal responses and ten designed to evoke figural responses. Criterion referenced items may be defined as "the interpretation of an individual's score by comparing it to a pre-specified standard of performance" (Gall, Gall, & Borg, 2003, p. 206).Verbal items include the richness of the generated imagery "defined as variety, vividness, and strength

of imagery" (Goff & Torrance, 2002, p. 7); depictions of emotions or feelings; projecting future consequences or considering the "what if?" inherent in a task; responding in such a way as to touch another's sense of humor; and provocative questions or considering new perspectives (Goff & Torrance, 2002).

The ten figural indicators consist of openness or the ability to delay closure long enough to "make the mental leap that makes possible original ideas" (Goff & Torrance, 2002); unusual visualization or the ability to realize a variety of perspectives; depicting movement or sound; conveying richness and color; producing abstract titles for one's work; articulating detail; synthesizing of two or more figures; ability to illustrate the internal workings of an object; expressing feelings and/or emotions; and expressing fantasy (Goff & Torrance, 2002). These figural indicators may or may not be present in every response. Scoring consists of a double plus (++) indicating multiple presences of the creativity indicator. A double plus (++) is assigned a numerical score of 2. A single plus (+) indicates a single rendition of a creativity indicator and is assigned a numerical score of 1. A blank rating indicates no evidence of a creativity indicator and is given a numerical score of 0.

A Creativity Index is then compiled for each respondent. It consists of a combined score of the sum of individually assessed abilities of fluency, originality, elaboration, and flexibility as well as sum of the total number of creative indicators. A seven-point scaled score was developed to interpret the creativity index with 7 indicating substantial creativity as found in the top 4% of adults (Goff & Torrance, 2002). A creativity index of 4 is average or the mid-point of the scale. It is expected that teachers scoring effective on the COS-R will score 4 or higher on the Creativity Index.

Internal consistency, an estimate of test score reliability, involves examining individual test items (Gall, Gall, & Borg, 2003). The Kuder-Richardson Formula 21 (KR21) is one such type of item analysis. The Creativity Index yields a KR21 reliability of .90 for a composite of creative abilities and indicators (Goff & Torrance, 2002). The following table separates the KR21 reliability coefficients for ATTA ability scores:

Table 5: KR21 Reliability Coefficients for ATTA Separate Ability Scores

Score	*KR21*
Fluency	.45
Originality	.38
Elaboration	.84
Flexibility	.38
Total Creativity Indicators	.69

Table adapted from: Goff & Torrance, 2002. Abbreviated Torrance tests for adults manual. IL: Bensenville. Scholastic Testing Service, Inc.

Rater reliability, or the degree to which correlation of scores is achieved by independent scorers, reveal inter-rater reliabilities ranging from .95 to .99. Rater reliability studies are ongoing; thus caution will be used when interpreting the scores from the proposed sample. The Abbreviated Torrance Test for Adults (ATTA) may be found in Appendix B.

Classroom Observation Scale-Revised

The rationale for the COS-R includes "advancing the introduction of innovative instructional practices into the classroom, such as inquiry learning, critical and creative thinking skills, higher order questioning strategies [and] metacognition" (VanTassel-Baska, 2005). Simply put, the COS-R "assesses individual teacher performance in response to high ability learners" (VanTassel-Baska, et al., 2005) in the categories of curriculum planning and delivery, accommodations for individual differences, problem solving, critical and creative thinking strategies, and research strategies, as these were

considered the most significant teaching behaviors during the COS-R development process.

The COS-R's subscales consist of three to five clusters or descriptors of teacher behaviors or characteristics of observable teaching. Each item on the subscale is rated according to its observed effectiveness on a rubric which ranges from 3-Effective to 1-Ineffective. A Not Observed option indicates that the behavior was not present during the observation period. The technical adequacy of the COS-R includes the instrument's reliability or "degree to which measures are free from error and therefore yield consistent results" (VanTassel-Baska, et al., 2005). A reliable instrument generally yields a low of .7 and a high of .89 (Bracken, 1993, 1996). Pilot data for the COS-R suggests an overall reliability rating of .92 (VanTassel-Baska, et al, 2005) when employed in teams of two observers per classroom at a given period to strengthen inner-rater reliability.

The Teacher Inputs/Activities Questionnaire

Based on the work of Wenglinsky (2000), the Teacher Inputs/Activities Questionnaire has been used to gather data in needs assessments as well as pilot studies and yields a rich cross-section of information pertaining to teacher background and professional development. Wenglinsky maintains that the items extant on the questionnaire are essential for fostering higher order thinking skills in the classroom. The questionnaire probes the following inputs: years teaching of experience; highest degree earned; major in subject; current teaching assignment; number of students identified gifted; how many hours of specific types of professional development the teacher received during the past year that were offered by the district; and how many hours of

specific types of professional development the teacher received during the past year that were sought independently by the teacher.

The activities section of the questionnaire is intended to explore Research Question One in detail. Descriptive statistics were used to analyze data across teachers. To date, no validity or reliability data have been found on the Teacher Inputs/Activities Questionnaire. Repeated attempts to contact Professor Wenglinksy by traditional means as well as electronically went unanswered. The complete Teacher Inputs/Activities Questionnaire may be found in Appendix C.

Richard Paul's interview protocol developed for the California Commission on Teacher Credentialing (1997) was selected as the interview protocol for this study. The protocol consists of both closed- and open-ended questions. The questions involve participants' conceptions of critical thinking; the struggle between content versus coverage and the impact both have on the development of critical thinking skills; important ways the participants seek to foster critical thinking skills in the classroom and participants' understanding of key terms and concepts associated with critical thinking in general. Paul conducted interviews both with Education faculty (n=101) and Subject Matter faculty (n=39). The response rate for Education faculty was 79% while the response rate for Subject Matter faculty was 65% (Paul, Elder, & Bartell, 1997).

Procedures for the Study

The study was conducted from January through June of 2006. In this study, a variety of methods was used to collect data: the researcher administered the Watson-Glaser Critical Thinking Appraisal-Form S (WGCTA) to the study's participants; the researcher administered the Abbreviated Torrance Test for Adults (ATTA) to the study's participants; the researcher selected interview participants based on COS-R scores;

interview participants completed a short questionnaire on the inputs they bring to the classroom and on specific critical and creative thinking activities; and participants submitted to an hour-long standardized open-ended interview. The researcher conducted abbreviated observations of selected classrooms at the conclusion of the interviews.

Participants were contacted by telephone, e-mail, and letter and were assured that there would be no negative effect on their job status or placement regardless of whether or not they agreed to participate in the study.

The authenticity of a study's procedures and results--specifically the treatment of participants is of the utmost concern in any research study. Authentic studies attempt to gain a true understanding of people's experiences (Schwandt, 2001). Fairness is one way to establish authenticity (Dimock, 2001). This means ensuring equity in the rights of participants in that adequate opportunities for self-expression are provided and fairly represented. Ensuring fairness includes informing participants of pertinent information regarding the study and their participation. The study's purpose and procedures were discussed individually with each participant. Confidentiality of data was assured, and participants were offered a copy of the final study in an effort to establish educative authenticity or ways for the participants to learn about others.

Description of the Data Collected

Data collected from this study included scores from the Watson Glaser Critical Thinking Appraisal-Form S (WGCTA) and the Abbreviated Torrance Test for Adults (ATTA). They included answers generated on the Teacher Inputs/Activities Questionnaire as well as participant responses to standardized open-ended interview protocol. Responses were transcribed and coded according to Paul's open-ended coding

sheets, and were examined for emergent themes. A table of specifications providing the research questions, data sources, instrumentation, and data analysis techniques is provided in Table 6.

Table 6

Table of Specifications for Research Study

Quantitative Research Question	**Sample Size = 24**	**Instrumentation**	**Data Analysis**
Are there differences between experimental and comparison teachers participating in Project Athena with respect to training and experience in teaching critical thinking and other inputs of advanced learning that might affect the use of higher order thinking skills?		Teacher Inputs and Activities Questionnaire	Descriptive statistics: means, standard deviation, frequency counts
What differences are there between experimental and comparison teachers participating in Project Athena on tests of critical thinking?		Watson-Glaser Critical Thinking Appraisal-Form S (WGCTA)	Descriptive statistics : means, standards deviation, frequency counts
What differences exist among Project Athena teachers on a test of creative thinking?		Abbreviated Torrance Test for Adults (ATTA)	Descriptive statistics; means, standard deviation, frequency counts
Qualitative Research Questions	**Sample Size = 7**		
How do Project Athena experimental and comparison teachers define critical and creative thinking?		Interview	Inductive Analysis (Paul's open ended coding sheet; axial coding; emergent themes; member checks)
What specific types of critical thinking activities do Project Athena teachers employ in classrooms? Do they differ between experimental and comparison teachers?		Interview	Inductive Analysis (Paul's open-ended coding sheet; axial coding; emergent themes; member checks)

Data Analysis

Quantitative Analysis

Because the WGCTA-Form S and the ATTA report results use different criteria, descriptive statistics were used to analyze generated data. Descriptive statistics were also used to analyze data from the Teacher Inputs Questionnaire. The extent to which teacher inputs/activities and critical and creative thinking ability correlate with the teacher scores on the Classroom Observation Scale-Revised (COS-R) was examined and described as well.

Qualitative Analysis

Data analysis began with the first interview. Data was coded using Paul's coding sheet, but was also inductive. Inductive analyses are a method of examining ideas expressed by the participants' emic views instead of pre-coding categories structured by the researcher a priori (Rossman & Rallis, 2003). Data from the interviews were summarized, unitized, and coded categorically (Rossman & Rallis, 2003) with words and phrases representative of the data unit contents. Data units were placed in categories using axial coding and then larger categories were derived to reflect emergent themes (Strauss & Corbin, 1990). These codes were listed on paper and charted, after which they were rearranged into common categories that represented larger themes or generalizations reflective of participants' responses and perspectives as interpreted by the researcher. These codes may be found in Appendix F.

It is believed that this study's results are trustworthy, dependable, confirmable, and transferable (Patton, 2002). Credibility was established by data triangulation, member checks, and work with a data analysis expert.

Dependability, or consistency of the findings (Patton, 2002), was reflected in a reflexive journal. A reflexive journal is a documented account of researcher reflections and reactions regarding the study (Rossman & Rallis, 2003). A reflexive journal was kept throughout the process. Transferability, a component of trustworthiness, (Patton, 2002) involves the applicability of knowledge to future actions as well as rigorous evidential sources. Throughout the course of this study, quantitative data were diligently applied to participants' responses so that the study rendered transferable generalizations despite the limited sample size.

Statement of Bias

When data collection commenced, the researcher was acting as a graduate assistant at a university center that provides services in the realm of programming and curriculum development within the field of gifted education. In conducting this study and sharing the results, the researcher hopes to build support for enhanced teacher education with respect to higher order thinking skills.

Resources

This study was conducted by one researcher. Costs included the printing of questionnaire materials, purchase of the Watson-Glaser Critical Thinking Appraisal-Form S (WGCTA), purchase of the Abbreviated Torrance Test for Adults (ATTA), purchase of software for data analysis, and the cost of travel within the states of Virginia and Maryland to conduct interviews. Additionally, a small gratuity was offered to teachers

who participated in the study. Funding was provided by the researcher. All data analyses, typing, and manuscript preparation were performed by the researcher.

Human Subjects Review

The study was conducted in a manner that protects the anonymity of all participants. Informed consent was utilized within the guidelines of Project Athena to protect the participants and notify them about the study's results. Participants were informed that their inclusion in the study was voluntary and anonymous. They were told that their assessment scores and interview responses are confidential and that their job status will in no way be affected whether or not they chose to participate in the study. Participant names will not be disclosed in any publication. Data will be made available only to the dissertation committee and the sample of participants. The data will be maintained by the researcher for potential use in follow-up studies.

Limitations & Delimitations

Limitations

Several limitations exist with respect to the proposed study which will affect the generalizability of its results. First, the study includes a descriptive component, meaning that "the characteristics of one sample at one point in time" (Gall, Gall, & Borg, 2003, p. 291) are reported. Because factors affecting teacher performance may differ at different points in time, the interview data collected may not reflect true practice.

Teacher history is a potential threat to the validity of the proposed study. Extreme cases were selected for the purposes of this study. Some of the teachers selected will have participated in a study of language arts curriculum for longer than others, while others were asked to participate by their administrators as teachers exited the grant.

Another limiting factor is sample size. There were potentially 60 Project Athena teachers who were asked to take the WGCTA and the ATTA. Only 24 teachers submitted to testing. Additionally, there were 17 teachers who scored a mean of 2.50-3.0 (effective) on the critical and creative thinking subscales of the COS-R. Only twelve of those teachers submitted to interviews, yet five were discarded as unusable. This small sample size yielded rich information yet limits generalizability of the study's results to other populations.

Delimitations

Implementation of Project Athena spans seven school districts in three states on the eastern seaboard. While it would have been highly desirable to include teachers from all seven school districts in the study, one school district was intentionally excluded as constraints on researcher time and resources are a reality.

Additionally, the study relies on general definitions and conceptions of the terms studied due to lack of cohesion across the field because "when educators talk about higher cognitive processes, they often use the names of higher order cognitive processes used to mean any higher order thinking skill" (Woodward, 2000, p.1). The definitions used in this study were further narrowed to those deemed most acceptable for use within the field of gifted education.

Another factor that limits the scope of the study includes the collection of comparative student data. While including student achievement data would have enhanced the scope of the study, the researcher intentionally chose to focus solely on teacher data.

Chapter 4

Analysis of Results

Introduction

The purpose of this study was to determine how well elementary language arts teachers participating in a federal project to raise students' critical thinking scored on tests of critical and creative thinking. Furthermore, it investigated the ways in which these teachers of the language arts have developed their understanding of critical thinking skills, what types of training they bring to the classroom which might enhance the teaching of critical thinking skills, and the methods by which they foster critical thinking in the classroom.

Analysis of Results

This study was completed during the summer of 2006 using the following instruments: The Wenglinsky Questionnaire, the Watson Glaser Critical Thinking Assessment (WGCTA), the Abbreviated Torrance Test for Adults (ATTA), and Paul's interview protocol. WGCTA, ATTA, and Wenglinsky questionnaire data were collected prior to conducting individual interviews at a training institute conducted by the Center for Gifted Education at the College of William and Mary in March of 2006. Interview data were collected from March of 2006 through May of 2006. Qualitative data from the interviews were analyzed using Paul's coding sheet. Data from the interviews were further analyzed using inductive and interpretive coding and thematic content analysis (Patton, 2002; Rossman & Rallis, 1998).

Experimental and comparison teachers instructing in grades three through five from five schools that were part of Project Athena, a Jacob Javits grant awarded to The

Center for Gifted Education at the College of William and Mary, participated in this study. WGCTA, ATTA, and Wenglinsky questionnaire data were collected from twenty-four teachers, and interviews were conducted with seven of those teachers. The rationale for the selection of this sub-sample of teachers was discussed in Chapter 3 of this study.

Report of Findings

This chapter presents the results of the study organized by data source and research question. First, Project Athena's teacher population will be described briefly to provide contextual information while maintaining the confidentiality of the participants from each school. Then quantitative results on the WGCTA and the ATTA will be shared. The interview data will be presented in two parts: first, according to Paul's coding sheet and then thematically to include a discussion of how teachers employed critical and creative thinking in their classrooms.

Project Athena's Teacher Population

Project Athena's 71 teacher participants were randomly assigned to an experimental (N=71) or control condition (N=34). Among the group, 16 experimental and 15 comparison teachers remained in the study for three years. Participants for the current study were solicited from six of the seven Project Athena districts. Although the researcher contacted each teacher individually, only 24 teachers agreed to participate in the study. Of this group, 24 teachers took the WGCTA and the ATTA, but only 15 of those teachers returned the Wenglinsky Questionnaire. The majority of these participants (91%) were a part of Project Athena for two or more years.

Are There Differences Between Experimental and Comparison Teachers Participating in Project Athena With Respect to Training and Experience in Teaching Critical Thinking and Other Inputs of Advanced Learning that Might Affect the Use of Higher Order Thinking Skills?: Wenglinsky Questionnaire Results

This study's small sample size renders it difficult to draw generalizations from the data; however, more similarities than differences were found between these two groups of teachers. Similarities include the length of time teachers remained at their assigned grade level, years of service reported, and the fact that both groups of teachers reported seeking more professional development hours outside of their districts. On the other hand, one pertinent difference between these two groups includes the fact that experimental teachers received more professional development in gifted education and cooperative learning strategies, two areas of professional development that Wenglinsky (2004) reports should increase critical thinking ability. Data generated from this study are discussed in detail below.

The Wenglinsky Questionnaire asked respondents to report on the professional development they received over the past year that was offered by their school division as well as the professional development that was sought independently by the educator. The rate of return of the Wenglinsky Questionnaire was 62%. Participants who consented to complete the questionnaire (N=15) were either experimental (N=6) or comparison teachers (N=9) and had worked with Project Athena from one to three years. Table 7 provides an overview of the average number of professional development hours mandated by districts and the average number of professional development hours sought independently by experimental and comparison teachers.

Experimental teachers (N=6) averaged 18 years' of teaching experience while comparison teachers (N=9) reported an average of ten years in the classroom. Of the six experimental teachers who responded to the questionnaire, 50% achieved a master's degree and 50% had bachelor's degrees. Of the nine comparison teachers who responded to the questionnaire, 40% achieved master's degrees while 60% had bachelor's degrees. None of the respondents had earned doctorates. Both experimental and comparison teachers reported having an average of three students in their classrooms who were identified as gifted.

Experimental teachers (N=6) reported receiving an average of three days of training offered by the district in gifted education strategies. An additional average of three days training in gifted education strategies was sought by these educators independently. This number includes the training offered under Project Athena during the current year. Comparison teachers (N=9) also averaged three days of training in gifted education strategies when offered by their district, but averaged only one day of independently sought training in this area of professional development.

Experimental teachers (N=6) related receiving an average of one day of district mandated training in assessment strategies and reported independently seeking an average of six days of training on this topic. Comparison teachers (N=9) stated that their districts offered them an average of two days of training on assessment strategies. On average, comparison teachers sought three additional days of professional development concerning assessment strategies.

Districts offered experimental teachers (N=6) an average of one day of training regarding the content areas they teach. These teachers sought an average of one

additional day independent of school district direction. Comparison teachers (N=9) report that their district mandated three professional development days on average with respect to content area training. These teachers sought an additional two days of professional development in the content areas.

Experimental teachers (N=6) stated that districts offered a half day of training on cooperative learning strategies. These teachers sought an average of six additional days of training regarding this area of professional development. Comparison teachers (N=9), on the other hand, indicated that they received no training on cooperative learning strategies from their districts, and only sought an average of one day of training independent of their districts.

Experimental teachers (N=6) specified that they received two days of district-mandated professional development regarding technology. On average, these teachers sought one additional day of training in technology. Comparison teachers (N=9) were offered three days of training in technology by their districts and sought an average of two additional days in this area of training.

Districts offered experimental teachers (N=6) an average of one day of training on teaching methods, and these teachers sought an average of one additional training day on teaching methods. Comparison teachers (N=9) received an average of two professional development days from their districts. Comparison teachers sought an additional two days of professional development on the topic of teaching methods.

Experimental teachers (N=6) reported that their districts offered no training concerning strategies for special populations or for classroom management strategies. Experimental teachers sought an average of three days of professional development on

the topic of special populations but no days of training for classroom management. Comparison teachers (N=9), on the other hand, indicated that they were offered an average of one day of training by their districts regarding both special populations and classroom management strategies. In addition, these teachers sought an average of one additional day of training on special populations and two additional days on classroom management strategies.

Districts offered both experimental and comparison teachers an average of one day of professional development concerning higher order thinking skills. Experimental teachers independently received three additional days of training in higher order thinking skills. Comparison teachers independently experienced two additional days of this type of professional development.

Neither experimental nor comparison teachers reported receiving district-mandated professional development on integrating the curriculum. Experimental teachers, as a group, did not seek additional training in this area. Comparison teachers, however, reported independently receiving an average of an additional eight days of training on integrating the curriculum. Wenglinsky Questionnaire data are summarized in Table 7.

Table 7

Wenglinsky Questionnaire Results

Professional Development Type	Mean Experimental Hours Reported		Mean Comparison Hours Reported		Standard Deviation Experimental Teachers		Standard Deviation Comparison Teachers	
	Division Mandated	Self-Directed	Division Mandated	Self-Directed	Division Mandated	Self-Directed	Division Mandated	Self-Directed
Assessment Strategies	0.6	1.3	2.1	2.2	0.5	1.0	1.7	4.3
Content	0.5	0.8	2.8	1.8	0.8	1.6	3.4	4.0
Cooperative Learning	0.5	5.6	0.2	0.2	0.8	7.3	0.4	0.4
Technology	1.5	1.0	3.7	1.8	1.8	1.5	3.2	2.1
Teaching Methods	1.1	2.5	2.0	2.7	1.1	6.1	2.0	3.6
Special Populations	0.1	2.5	0.8	0.6	0.4	6.1	1.3	1.0
Classroom Management	0.0	0.1	0.8	2.0	0.0	0.4	1.3	4.4
Higher Order Thinking	1.0	3.1	1.0	2.2	1.2	5.8	1.4	4.3
Interdisciplinary Teaching	0.3	0.0	0.6	9.0	0.8	0.0	1.3	20.0*
Gifted Education	1.3	2.6	2.6	0.2	1.0	6.0	1.7	0.4
Totals	6.9	19.5	16.6	22.7	8.4	35.8	17.7	44.5

*Note: Large standard deviation due to number of hours reported by teacher undergoing the National Board for Professional Teaching Standards certification process.

What Differences are There Between Experimental and Comparison Teachers Participating in Project Athena on Tests of Critical Thinking?: Watson- Glaser Critical Thinking Assessment-Form S (WGCTA) Results

The Watson-Glaser Critical Thinking Assessment was administered to Project Athena teachers (N=24) who agreed to participate in this study. The study's small sample size makes it difficult to draw generalizations based upon the data. Some differences emerged when scores were examined. These differences include the fact that Project Athena experimental teachers scored higher on the WGCTA on three out of five subtests. Additionally, scores on the WGCTA were significantly and positively correlated with a high number of professional development hours.

Experimental teachers (N=14) are those teachers who have received between one to three years of professional development on the William and Mary Language Arts Curriculum for High Ability Learners. According to training schedules maintained at the Center for Gifted Education, College of William and Mary, approximately one-third of this training was devoted to critical thinking in terms of Paul's Reasoning Model in each of the professional development sessions. Comparison teachers (N=10) are those teachers who received no training on the William and Mary Language Arts Curriculum for High Ability Learners during the course of their years of Project Athena's implementation.

The Watson-Glaser Critical Thinking Assessment (WGCTA) is divided into five subtests: inference, recognition of assumptions, deduction, interpretation, and evaluation of arguments. Each subtest was administered to all participants (N=24), regardless of whether they were experimental or comparison teachers. Scores for the

WGCTA are reported as raw scores; the maximum raw score is 40 for Form S. Raw scores are than compared to normative data to provide a basis for evaluating an individual's raw score relative to the scores of others who took the same test (Watson & Glaser, 1994). Table 8 summarizes the WGCTA data.

Table 8

Watson-Glaser Critical Thinking Assessment-Form S Results

	Experimental (N=14) (percentage)	Comparison (N=10) (percentage)	Nurse Managers & Educators
Overall Average[a]	52	43	62
Subtests[b]:	Percentage Correct	Percentage Correct	
Inference	64	67	100
Assumptions	87	75	100
Deductions	65	65	69
Interpretations	79	74	69
Evaluating Arguments	84	78	88

Note. [a] computed based on Combined Group Norms for Nurse Managers and Educators table from raw score totals.

[b] computed by dividing number right by number of subtest items.

As a group, experimental teachers averaged a higher score (52%) than comparison teachers (43%) on the WGCTA-Form S. Experimental teacher scores ranged from 3% to 99% on the WGCTA-Form S while overall scores for comparison teachers ranged from 1% to 97%. There were also differences within the WGCTA-Form S subtests. For instance, comparison teachers averaged a slightly higher score (67%) on the

subtest of inferences which involves discriminating among degrees of truth or falsity of inferences drawn from given data than did experimental teachers (64%). Comparison teachers also marginally outperformed experimental teachers on the subtest of making deductions, or determining whether certain conclusions follow from given statements or premises. Experimental teachers, on the other hand, scored higher than comparison teachers when recognizing assumptions (87% to 75%), interpreting evidence (79% to 74%), and evaluating arguments (84% to 78%).

A closer examination of these scores revealed that subtest scores for experimental teachers ranged from 64% to 87% while subtest scores for comparison teachers ranged from 65% to 78%. Six experimental teachers scored above the 50th percentile on the WGCTA. Of experimental teachers scoring above the 50th percentile, five achieved scores in the 90th percentile. Additionally, three comparison teachers scored above the 50th percentile on the WGCTA, and two out of these three teachers scored in the 90th percentile.

What Differences Exist Between Experimental and Comparison Project Athena Teachers on a Test of Creative Thinking?: Abbreviated Torrance Test for Adults Results.

The same sample of Project Athena teachers who were assessed using the Watson-Glaser Critical Thinking Assessment (N=24) were also assessed using the Abbreviated Torrance Test for Adults (ATTA). Table 9 summarizes the ATTA data.

Table 9

Abbreviated Torrance Test for Adults- Results

	Experimental Teachers (Percentage of sample in a particular level)	Comparison Teachers (Percentage of sample in a particular level)	Normalized Standard Scores (Percentage of adults in a particular level)
Creativity Level 7 (Substantial)	23	18	4
Creativity Level 6 (High)	30	27	12
Creativity Level 5 (Above Average)	23	18	20
Creativity Level 4 (Average)	7	9	26
Creativity Level 3 (Below Average)	0	9	20
Creativity Level 2 (Low)	7	0	12
Creativity Level 1 (Minimal)	7	18	4
Totals	97	99	98

It is not possible to construct significant generalizations from the ATTA data due to the study's small population size; however, in general, more differences than similarities exist between Project Athena experimental and comparison teachers. Project Athena experimental teachers scored marginally better on the ATTA than comparison teachers. This is reflected by the percentages of teachers who fell into the *substantial, high,* and *above average* categories of the test (76%) as compared to comparison teachers in the same categories (63%). Both sets of teachers were well above the normalized standards in the substantial and above average ranges published by Goff & Torrance (2002).

The ATTA consists of three activities. Each individual activity was administered within a three minute time limit. Each activity was assessed for four norm-referenced abilities and fifteen criterion-referenced indicators (Goff & Torrance, 2002). The norm-referenced abilities are fluency, originality, elaboration, and flexibility while the fifteen criterion-referenced indicators are considered either verbal or figurative responses. Raw scores were converted to scaled scores so that scores could be compared and a creativity index could be calculated. The creativity index was then interpreted as a verbal assessment of *minimal, low, below average, average, above average, high,* or *substantial,* and corresponding creativity levels of one through seven were assigned in accordance with the *Abbreviated Torrance Test for Adults Manual* (Goff & Torrance, 2002).

The highest scoring Project Athena teachers on the ATTA included two comparison teachers and three experimental teachers. Each of these teachers achieved a creativity index of seven and a *substantial* rating, placing them within a population of four percent of adults who score within this range.

Teachers who achieved a creativity index of six and a rating of *high* numbered seven out of this population. Comparison teachers numbered three while there were four experimental teachers in this group. These teachers placed in the top 12% of the adult population who score within this range.

There were five Project Athena teachers who fell within the Creativity Index of 5 or *above average*. Two of these teachers were comparison teachers and three were experimental teachers. Generally, the top 20% of adults who take the ATTA fall into this category.

There were two Project Athena teachers who scored a Creativity Index of 4. This rating received a verbal assessment of *average*. This rating was assigned to one comparison teacher and one experimental teacher, and the rating represents 26% of the adult population who take this test.

A comparison teacher working with Project Athena received a Creativity Index of 3 or a *below average* rating, while an experimental teacher working with the project received a 2 or a *low* rating. The comparison teacher fell within the 20% of the adult population who have been assessed as below average on this test, and the experimental teacher represented the 12% of the adult population scoring in the *low* category.

Finally, two comparison teachers and one experimental teacher received *minimal* ratings on the ATTA. These teachers were assigned a creativity level of 1 and fell within the 4% of the adult population who score at this level on the ATTA.

How do these Project Athena experimental and comparison teachers define critical thinking?: Interview Data Results

Of the teachers who took the WGCTA and the ATTA, seven teachers from three school districts representing five schools agreed to be interviewed so that Research Question 4: *How do these teachers define critical thinking?;* and Research Question 5: *How are critical and creative thinking activities employed in these classrooms? Do they vary between experimental and comparison teachers?* could be answered. Results of frequency counts calculated from answers coded to Paul's Coding Sheet indicate that neither experimental nor comparison teachers could clearly articulate a definition for critical thinking. On the other hand, inductive analysis of interview responses suggest that the participants saw critical thinking as involving the provision of evidence or proof

of one's thinking through analysis and the consideration of multiple perspectives in order to make relevant connections using skills such as discussion and questioning.

All participants agreed to be audio-taped. Four of the interviewees were Project Athena experimental teachers who received training on the William and Mary Curriculum for high ability learners and three of the participants were comparison teachers who received no training on the curriculum at the time of the interview. Each interview lasted approximately one hour and was transcribed verbatim and coded using the coding sheet (Appendix E) developed by Richard Paul for his study concerning critical thinking practices of university faculty: *California Teacher Preparation for Instruction in Critical Thinking: Research Findings and Policy Recommendations* (Paul, Elder & Bartell, 1997). Interviews were further examined for emergent themes as previously described in Chapter 3.

The data obtained from utilizing Paul's coding sheet (Paul, Elder & Bartell, 1997) are summarized in Table 10. The coding sheet adheres to strict definitions of the conceptions of critical thinking and terms associated with critical thinking practices. Therefore, answers were coded to evidence little or no *conception* of a topic, *limited conception* of a topic, or an *elaborated conception* of a topic based on the level of vagueness of an answer, the misconceptions apparent in an answer, digression from a question's topic, or the presence of contradiction in a description given by the interview participant. As with all of the data generated by this study, it is difficult to make generalizations regarding these questions due to the study's small sample size.

As shown in Table 10, use of the coding sheet yielded the information that five of the seven interview participants had little or no conception of critical thinking. Typical responses from participants who have little or no conception of critical thinking include statements such as, " think[ing] beyond what is obviously stated," "think[ing] through a problem," and "giving a deep answer."

Two of the interview participants, both Project Athena experimental teachers, showed limited conceptions of critical thinking. Typical answers representing limited conceptions include phrases like, " put[ting] aside assumptions," "making judgments," and asking, "which strategy works best for you?"

Participant descriptions of a typical class day that fosters critical thinking evidenced that five of the seven interviewees could describe events in the classroom that led to critical thinking practices in a limited manner. Four of the five teachers with the limited ability to describe critical thinking practices were Project Athena experimental teachers; one was not. In general, responses from teachers who could describe classroom events that led to critical thinking practices in a limited manner, included statements like, "[my students] have to have evidence and proof for everything," "I am constantly making them look for information and make connections," "It's easy to answer without the elaboration because then they don't have to think about why they think that," and "they're encouraged to ask questions and have discussions."

The remaining two teachers, Project Athena comparison teachers, had little or no ability to describe events in the classroom that foster critical thinking practices. Their answers included statements such as, "we do a lot of partner work," "they have to choose an answer," and "saying 'I don't know' is not an option."

A Project Athena experimental teacher was able to articulate an elaborated conception of reconciling covering content with fostering critical thinking by citing specific examples of "open discussion. . .connect[ing] the content to prior knowledge and other experiences. . .and "examin[ing] author's intent." Two teachers evidenced limited conceptions of this same topic. Of the two teachers with limited conceptions of reconciling covering content with fostering critical thinking, one was a Project Athena experimental teacher; the other was a comparison teacher. Typical statements involved suggestions of "building models in your mind," and "weaving ideas together." The remaining four participants had little or no conception of this topic when they suggested that "hav[ing students] write a report" or not answering the question directly was evidence of reconciling covering content with fostering critical thinking.

When asked about critical thinking skills that are most important for students to develop, six of the seven participants articulated a limited conception of this topic. Typically, teachers with a limited conception of this topic cited Bloom's Taxonomy or "higher order thinking skills" without specifically addressing them. The remaining teacher, an experimental teacher, described little or no conception of student development of critical thinking skills.

Additionally, two teachers, one experimental and one comparison, were able to describe in an elaborated fashion how to assess a peer who was or was not fostering critical thinking in the classroom. The elaborated responses included statements such as "I would examine the student/teacher ratio of who was doing the talking," and "I would speak with the students one-on-one and say, 'Tell me how you were taught to do this.'"

A limited conception of the same topic was offered by four of the teachers, most of whom cited visiting the classroom and observing the teacher as a way of determining whether or not critical thinking was occurring in the classroom. A Project Athena experimental teacher evidenced a little or no conception of how to assess a peer fostering critical thinking in the classroom. This teacher cited observing students to see if they made journal entries on what they did that day as her measure of whether or not critical thinking was occurring in a colleague's classroom.

When asked about their personal conception of intellectual standards, three teachers were able to offer limited conceptions of this topic, using words like logic, quality, and elaboration to enhance the discussion. Of these three teachers, two were Project Athena experimental teachers. The remaining four teachers offered limited conceptions of intellectual standards, likening intellectual standards to curiosity or equating working independently with critical thinking.

When asked to explain the difference between an assumption and an inference, two participants, both Project Athena experimental teachers, offered elaborated definitions. Their definitions included statements like "an assumption doesn't have basis in fact," and "an inference uses information that you have." These teachers used examples to support their definitions. An additional two teachers, one experimental and one comparison, offered limited definitions of this topic. One teacher said, "If it's an inference, can they prove to me how they came up with it? If it's an assumption, did they just pull it out of the sky?" Teachers with little or no concept of the difference between an assumption and an inference stated that "they must be opposites," or that "an inference is a prediction."

Participants were also asked to explain the difference between an inference and an implication, and two teachers were able to offer limited discussion of these two concepts. Both were Project Athena experimental teachers and equated implications with cause and effect as well as consequences. The remaining five teachers had little or no conception of the difference between an inference and an implication and exhibited puzzlement about the question through statements such as "This is really hard."; "Implication to me means that you're accusing someone of something." or "Well, the implication is what happens."

Table 10

Results of Paul's Coding Sheet by Question

	Elaborated Conception	Limited Conception	Little or No Conception	Totals
Concept of Critical Thinking	0	2	5	7
Typical Class Day	0	5	2	7
Covering Content vs. Critical Thinking	1	2	4	7
Important Critical Thinking Skills	0	6	1	7
Peer Assessment	2	4	1	7
Intellectual Standards	0	3	4	7
Assumption vs. Inference	2	2	3	7
Inference vs. Implication	0	2	5	7
Subtotals	5	26	25	49

Because Paul's coding sheet depends on language that adheres to a stringent level of specificity with respect to Paul's definitions of critical thinking and intellectual standards, interviews were also examined for emergent themes. Data analysis of interviews began with the first interview and was inductive. Inductive analyses are a method of examining ideas expressed by the participants' emic views instead of precoding categories structured by the researcher a priori (Rossman & Rallis, 2003). Data from the interviews were summarized, unitized, and coded categorically (Rossman & Rallis, 2003) with words and phrases representative of the data unit contents. Data units were placed in categories using axial coding and then larger categories were derived to reflect emergent themes (Strauss & Corbin, 1990). These codes were listed on paper, matched with critical thinking practices, charted, and then rearranged into common categories that represented larger themes or generalizations reflective of participants' responses and perspectives as interpreted by the researcher. The themes that emerged from this process included: using evidence to support an opinion, making connections, and considering alternate perspectives.

Providing evidence or proof of one's thinking process emerged as a form of critical thinking in conversation with this group of participants. Teacher A, for example, stated that "look[ing] for evidence, and looking for data that supports the evidence" is the basis for her concept of critical thinking. She "hold[s] them accountable for some sort of elaboration . . . [to] show [her] the evidence, compare it to something else." Teacher E considered being able to explain one's thinking in a logical manner proof of critical thinking as well. She stated that if her students "can give a reason or explanation and they can back it up with a probable cause for that explanation" then she knows they're

thinking critically. She used the example of a student choosing to use one diagram over another and his explanation that it was a better representation of a certain concept than another one as proof of student critical thinking. Teacher D declares that she "whys her students to death," making them present evidence and proof for their opinions in "just about everything." Teacher A echoed the importance of asking the question, 'why?' when she stated that "it's easy [for her students] to say 'yes' or 'no' without the 'because' or 'why' because then they don't have to think about why they think that."

Teacher D included persuasion in her discussion of providing evidence to support one's opinion. She declares that it "is important to [students to develop interests and a wanting to know . . . to analyze deep down and to try to convince other people that they want to know too." Additionally, she uses persuasion as the benchmark by which she would judge other teachers' ability to get their students to think critically when she states that she would ask another teacher's children to "try to prove to me something."

Several teachers equated making connections from one's personal life as evidence of critical thought as shown by class discussion and student-generated questions. Teacher B's students regularly practice discussions in which thoughtful questions are encouraged resulting in students "mak[ing] connections with things that have usually happened to them too. Additionally, this teacher consistently uses content areas such as social studies to offer students opportunities to "connect to prior knowledge and somehow respond to the information that [they] learned and discussed that day in class." Teacher C practices similar techniques in the language arts. She considers low level questions "just basically stating facts, so that when we read a fictional novel, they need to come forth with personal connections . . . they can make to this novel. Or they

have to make inferences about characters and problems and things like that." She selects novels beyond the state-required reading list to help her students connect to personal experiences, and she can tell the difference between novels that students don't immediately connect to and those that they do. Teacher C knows "when they hang on every word, they can make a connection to [the main character]." In math, she tried to help students "make real-world connections." She wants her students "to see how they're going to use math and why it is important so they can look around their world and see what would be used for perimeter—that type of thing." Teacher A stated that she tries to use a variety of questioning strategies based on Bloom's Taxonomy, accepting and encouraging all answers instead of "one answer or response that the teacher is looking for without consideration of other points of view." She encourages answers to include a variety of personal experiences so that students can make connections and compare and contrast peer group experiences. Teacher F related that he asks students to apply what is experienced or read to real life situations, usually as a culminating activity. He allows students to experience a learning event and then asks them to comment on the roles they took on during the experience. Teacher F values the input the students have during these experiences because the learning and commentary originates from them instead of being imposed upon them. He stated, "It's their own and not the teacher's. If it's the teacher's, they're not thinking critically, they're just paraphrasing. If they internalized it and they understand it, then they can take it from any angle; they can take it backwards, they can take it through the steps, they can describe it."

Finally, perspective plays an important role in this sample's understanding of critical thinking processes. Teacher B equated perspective with "being able to step out of

their shoes and try[ing] to put on someone else's shoes." She encourages doing so in the class room because she believes it "fosters their understanding of the world around them that they have to deal with more and more as they become more independent." Teacher F stated that not only is perspective important in his classroom, but that looking at issues and their consequences from multiple perspectives in an unbiased manner when one's assumptions are discarded is of tantamount importance. Teacher F selects issue-based topics for forums on perspective.

> "We read a lot of books that deal with issues like segregation—not just segregation in color, but segregation in people with disabilities, things like that. Serious issues that they see all the time. We discuss them, you know they feel pretty free to say what they think and feel and it's very interesting—even God. To talk about religion in the classroom without preaching it, but just to discuss that there are different ways; that we live in a pluralistic society. And those issues are important to these children. And, it's amazing to see what happens when two students who've been taught their whole life that one thing is the right way see that another student has been taught the exact same thing, and it's just as well to believe that as they have to believe their way. And they have to understand that both of them are allowed to feel that way; that you can't dislike the other person just because of that belief."

Teacher F added that perspective includes the ideas that one's actions hold consequences for other people's feelings in his discussion of perspective. He related a story of reading a poem with his class about the arch in St. Louis and how different groups of people think when they look through the arch with respect to westward expansion. One of his students exclaimed, "So our westward expansion is their (Native Americans) homelessness!" Teacher F explained that this example of empathy, in his experience, was often found in critical thinkers.

Teacher D asked students to apply their knowledge of history and the present day when she asked students to write an essay answering the question, "What if Martin

Luther King had lived?" One of the essays resulted in a perspective piece that combined the student's knowledge of economic choice and opportunity cost with the perspective that Martin Luther King had made an economic choice by giving up his life which in the child's mind was his opportunity cost. The essay resulted not only in a powerful perspective piece on the part of the student, but also in a series of perspective discussions on the part of the team of third grade teachers about whether or not the child should redo the essay because the results were not anticipated. Because the "insight, application of the concept, and evidence for perspective" were present, Teacher D modeled valuing everyone's perspective by not making the student rewrite the essay.

Results Analyzed by Individual Teacher Profile

Administration of the Wenglinsky Questionnaire, the Watson-Glaser Critical Thinking Assessment (WGCTA) and the Abbreviated Torrance Test for Adults (ATTA) generated individual teacher profiles which further highlighted differences between experimental and comparison teachers. Of the 24 teachers who consented to participate in this study, fifteen (62%) completed the Wenglinsky Questionnaire and took both the WGCTA and the ATTA. Profiles were created for these fifteen teachers to examine the interrelationships among their levels of critical thinking, creativity, teaching experience, and professional development experiences.

Teacher 1, a Project Athena experimental teacher, scored in the 99th percentile on the WGCTA. Making inferences (100%), recognizing assumptions (100%), and evaluating arguments (100%) were subtests on which this teacher scored high. Tasks on which this teacher scored lower included making deductions (88%) and determining whether conclusions or generalizations are logical (85%). The results of the ATTA

indicate a low (2) level of creativity for this teacher who has been an educator for nine years. Teacher 1 reports having experienced 29 hours of professional development during the past year. Hours mandated by her district number three, while the remaining 26 hours were sought by Teacher 1 independently of her district.

Teacher 2, an educator of nine years, scored in the 97th percentile on the WGCTA. Recognizing assumptions (100%), interpreting data (100%), and evaluating arguments (100%) were subtests on which this teacher scored high. Making inferences (57%) and deducing whether conclusions follow from given information (88%) were subtests on which this teacher scored lower. The results of the ATTA indicate that she exhibits a high level (6) of creativity. A Project Athena experimental teacher, Teacher 2 reports experiencing 100 hours of professional development over the past year; ten of these hours were mandated by her district, while 90 of them were sought independently of the district. This high number of professional development hours was due to the fact that this teacher was working to achieve National Board certification.

Teacher 3, a Project Athena comparison teacher serving in a different district from Teacher 2, also scored in the 97th percentile on the WGCTA. This teacher scored high on the recognizing assumptions (100%) and interpreting data (100%) subtests. Making inferences (85%), deducing whether conclusions follow from given information (77%), and evaluating arguments (88%) were subtests on which this teacher scored lower. A teacher of ten years' of experience, she exhibited minimal creativity (1) on the ATTA. Teacher 3 reports undergoing a total of 71 hours of professional development during the past year; 26 of these hours were mandated by the district, while 45 of them

were undertaken independently of the district. This teacher was also pursuing National Board certification.

Teacher 4, a Project Athena comparison teacher, scored in the 55th percentile on the WGCTA. Recognizing assumptions (100%) and interpreting data (100%) are subtests on which she scored high. This teacher's scores were lower on the subtests involving making inferences (42%), evaluating arguments (88%), and determining whether conclusions follow from information (66%) given. This teacher scored in the average (4) range on the ATTA. A teacher of ten years, Teacher 4 reports having experienced 18 hours of professional development during the past year. Of these 18 hours, six were mandated by her district, while 12 of them were sought independently of district mandates.

Teacher 5 scored in the 50th percentile of the WGCTA. Interpreting data (85%) and evaluating arguments (88%) were subtests on which this Project Athena comparison teacher scored high, while making inferences (57%), recognizing assumptions (25%), and determining whether conclusions follow from information given (77%) were subtests on which she did less well. Teacher 5 scored in the above average (5) range of the ATTA. She reports having taught for four years. Her professional development experiences of the past year include 58 hours. Hours mandated by her district totaled 13 while hours sought independently numbered 45.

Teacher 6 scored in the 45th percentile of the WGCTA. A Project Athena comparison teacher, she scored high on subtests involving recognizing assumptions (100%) and evaluating arguments (88%) and not as well on subtests dealing with making inferences (57%), determining whether conclusions follow from information given

(77%), and interpreting data (57%). Teacher 6 scored in the high (6) range of the ATTA. She reports having taught for five years and experienced twelve hours of professional development this year. Hours mandated by her district numbered seven, while the remaining five were sought independently of her district.

Teacher 7, a Project Athena comparison teacher, scored in the 10th percentile of the WGCTA. Recognizing assumptions (87%) and evaluating arguments (88%) are subtests on which she scored high. Making inferences (57%), determining whether conclusions follow from information given (33%), and interpreting data (42%) were subtests on which she scored less well. This teacher scored in the below average (3) range on the ATTA. A teacher with eleven years' of experience, Teacher 7 reported 20 hours of professional development experiences during this past year. The majority of hours, which numbered 18, were mandated by the district. The remaining two hours were sought by this teacher independently of district mandates.

Teacher 8 scored in the 35th percentile of the WGCTA. A Project Athena experimental teacher, this teacher scored well on subtests involving evaluating arguments (77%), interpreting data (71%), and making inferences (71%). Determining whether conclusions follow from information given (66%) and recognizing assumptions (62%) were subtests on which she scored less well. Teacher 8 scored in the minimal (1) range on the ATTA. She reported having one year of teaching experience in which she received 26 hours of professional development. Of these 26 hours, eight were mandated by her district; the remaining 16 were sought independently of district mandates.

Teacher 9 scored in the 32nd percentile of the WGCTA. Also a Project Athena experimental teacher, Teacher 9 scored high on the recognizing assumptions (100%) and

interpreting data (100%) subtests. Subtests on which she scored less well included making inferences (42%) determining whether conclusions follow from information given (88%), and evaluating arguments (66%). This teacher scored above average (5) on the ATTA. A teacher of thirteen years, she reported having had 34 hours of professional development during the past year. Of these 34 hours, four were district-mandated while 30 were not.

Teacher 10, a Project Athena comparison teacher, scored in the 30th percentile on the WGCTA. Determining whether conclusions follow from information given (88%) as well as making inferences (85%) were subtests on which this teacher scored high. Recognizing assumptions (62%), interpreting data (57%), and evaluating arguments (66%) were the subtests on which this teacher with five years of experience performed less well. Teacher 10 scored in the substantial range (7) on the ATTA. She reported experiencing 28 hours of professional development this year, 16 of which were mandated by her district. The remaining twelve hours were sought independently of the district.

Teacher 11, a Project Athena experimental teacher, scored in the 29th percentile on the WGCTA. Making inferences (85%) and interpreting data (85%) are the subtests on which he scored well. Recognizing assumptions (75%), evaluating arguments (77%), and determining whether conclusions follow from information given (55%) were the subtests on which he did less well. Teacher 11, who reported three years of teaching experience, scored in the substantial range (7) on the ATTA. He reported experiencing 22 hours of professional development during the past year. Of the 22 hours of professional development experienced, Teacher 11 stateed that 18 hours were mandated by the district, while four hours were sought independently.

Teacher 12, a Project Athena comparison teacher, scored in the 25th percentile of the WGCTA. Evaluating arguments (88%) and recognizing assumptions (87%) were subtests on which she performed well. Determining whether conclusions follow from information given (77%), interpreting data (71%), and making inferences (14%) were subtests on which she performed less well. Teacher 12 scored in the above average range (5) of the ATTA. A teacher with 23 years' experience, she reported experiencing 30 professional development hours, 27 of which were mandated by her district. The remaining three professional development hours were sought independently of her district.

Teacher 13, a Project Athena experimental teacher, scored in the 20th percentile of the WGCTA. Recognizing assumptions (100%) and interpreting data (85%) were subtests on which this teacher scored well. Evaluating arguments (77%), determining whether conclusions follow from information given (44%), and making inferences (28%) are subtests on which this teacher performed less well. Teacher 13 scored in the substantial range (7) on the ATTA. A teacher with 28 years of experience, she received eleven hours of professional development during the past year, ten hours of which were mandated by her district. The remaining hour was sought independently of the district.

Teacher 14 scored in the 20th percentile on the WGCTA. Making inferences (85%) and evaluating arguments (77%) were the subtests on which she performed well. Recognizing assumptions (62%), interpreting data (57%), and determining whether conclusions follow from information given (55%) weare the subtests on which she scored lower. Teacher 14 scored in the minimal range (1) on the ATTA. A teacher with ten years of service, she reported having experienced 19 hours of professional development

during this past year. Of these 19 hours, nine hours were mandated by her district. This Project Athena comparison teacher sought the remaining ten hours independently of the district.

Teacher 15, a Project Athena comparison teacher, scored in the 1st percentile of the WGCTA. Making inferences (85%) and interpreting data (71%) were the subtests on which she scored high. Recognizing assumptions (37%), evaluating arguments (33%), and determining whether conclusions follow from given data (11%) were the subtests on which she scored lower. This teacher scored a high rating (6) on the ATTA. A teacher of three years, she reported having received 16 hours of professional development during the past year. Of these 16 hours, twelve hours were mandated by the district, while the remaining four hours were sought independently of district activities. Results of Teacher Profiles are summarized in Table 11.

Table 11

Summary of Individual Teacher Profile Data

Experimental Teacher	WGCTA Percentile	ATTA Index	Years of Service	Professional Development Hours
1	99	2	9	29
2	97	6	9	100
8	35	1	1	24
9	32	5	2	34
11	29	7	3	22
13	20	7	28	11
Comparison Teacher				
3	97	1	10	71
4	55	4	10	18
5	50	5	4	58
6	45	7	5	12
10	30	7	5	26
12	25	5	23	30
14	20	1	10	19
7	10	3	11	20
15	1	6	3	16

Note: Teacher numbers correspond to numbers assigned in the text.

Teacher profiles were analyzed for individual patterns of achievement. Teachers who scored in the 70th percentile or above on the WGCTA were considered in the high range; those who scored between the 35th and 69th percentiles were considered in the medium range, and those who scored in or below the 34th percentile were considered in the low range. The Abbreviated Torrance Test for Adults was similarly analyzed. Participants who generated a creativity level of five to seven were considered above average or high, a creativity level of four was considered average or medium, and a creativity level of three or below was considered below average or low. These rankings are in line with the Abbreviated Torrance Test for Adults Manual (Goff & Torrance, 2002). Table 12 summarizes the profiles by overall WGCTA percentile and ATTA creativity level.

Table 12

Teacher Profile of Results on Critical and Creative Thinking by High, Medium, & Low Scores

	Critical Thinking				Creative Thinking			
	Experimental Teachers		Comparison Teachers		Experimental Teachers		Comparison Teachers	
	Number Teachers	Percent	Number Teachers	Percent	Number Teachers	Percent	Number Teachers	Percent
High	6	42	2	20	11	70	6	42
Medium	1	7	3	30	1	10	1	7
Low	7	50	5	50	2	20	3	33
Total	14	99	10	100	14	100	10	100

When analyzed according to profile, it appears that marginally more experimental teachers possess a greater ability to think both critically and creatively. Several intrasubject discrepancies in scores on critical and creative thinking emerged, however; when teacher profiles were examined. For instance, four teachers exhibited a highly creative profile but showed attitudes, knowledge, and skills of critical thinking that were low. Figure 1 illustrates these teacher profiles:

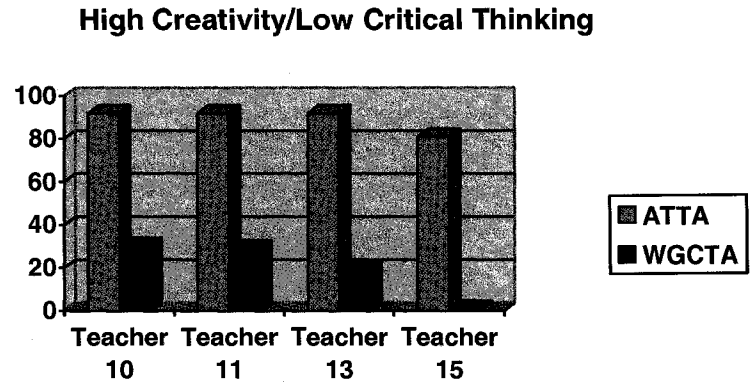

Figure 1

A second discrepancy in critical and creative thinking was exhibited by teachers who displayed low creative thinking but showed high critical thinking profiles. Figure 2 depicts these profiles for two teachers:

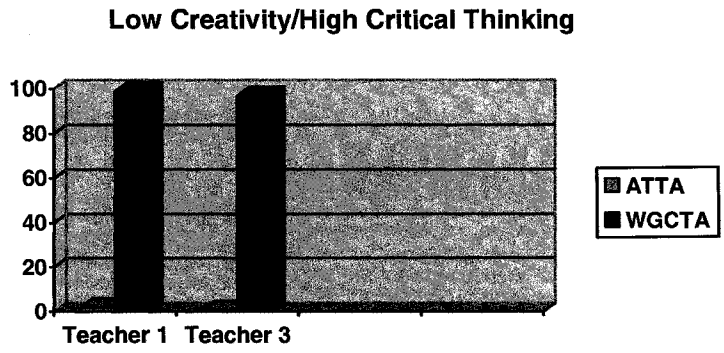

Figure 2

Additional Analyses of Teacher Results and Student Results on Critical Thinking

To add an additional dimension to the study analyses, available Project Athena data were examined to determine 1) how teacher scores on critical and creative thinking

may have affected student results on critical thinking, and 2) the relationship of COS-R observation scores to teacher results on those tests.

Critical thinking data for students included the Test of Critical Thinking (TCT) (Bracken, Bai, Fithian, Lamprecht, Little & Quek, 1999) which was given to all students in a pre-test, post-test model each year of Project Athena's implementation cycle. The TCT was designed to "assess critical thinking in students grades three through five" (Bracken, et al., 1999, p. 1); development of the TCT relied heavily on the Paul model of critical thinking due to the emphasis placed on it during Project Athena's intervention phase (Bracken, et al., 1999). The TCT Year 3 data were examined to determine how students in the classrooms of teachers participating in the study fared on pre- and post-test scores on the TCT. The Classroom Observation Scale-Revised (COS-R) scores were also examined. Year 3 COS-R pre- and post-observation data in the critical thinking domain was analyzed to see if the frequency of teacher behaviors regarding teaching critical thinking skills increased or decreased with respect to critical thinking. These data are summarized in Table 13.

Table 13

Critical Thinking and Project Athena Data

Experimental Teacher	WGCTA Percentile	Student TCT Scores		COS-R Ratings	
		Gain	Loss	Gain	Loss
1	99	.28	0	1.00	0
2	97	4.75	0	1.08	0
8	35	2.46	0	0	0
9	32	5.83	0	.33	0
11	29	1.00	0	.33	0
13	20	5.25	0	.50	0
Comparison Teacher					
3	97	0	0	0	0
4	55	3.33	0	0	0
5	50	6.0	0	0	0
6	45	.09	0	0	0
10	30	1.11	0	.33	0
12	25	2.65	0	0	0
14	20	2.4	0	0	0
7	10	1.73	0	0	0
15	1	3.10	0	1.0	0

All Project Athena experimental classrooms (N=6in this study demonstrated an increase in the ability to think critically as evidenced by higher scores on the TCT from pre- test to post-test, regardless of the score earned by the teacher on the WGCTA. Similarly, almost all Project Athena experimental teachers (N=5) gained when engaging in behaviors which fostered critical thinking in the classroom as evidenced by the COS-R pre- and post-observation data. Only one experimental teacher showed neither a gain nor a loss in this domain from the pre- to post-observation.

Most comparison classrooms (N=9) demonstrated an increase in student ability to think critically during the Project Athena Year 3 implementation phase, regardless of the teachers' scores on the WGCTA. Only one comparison classroom showed neither a gain nor a loss in student ability to think critically. This classroom's teacher scored in the 97th percentile on the WGCTA.

Two comparison teachers evidenced more frequent engagement in behaviors which foster critical thinking in the classroom as evidenced by the COS-R data. Both of these comparison teachers scored in the low range (below the 34th percentile) on the WGCTA. The remaining seven comparison teachers neither increased nor decreased their behaviors to foster critical thinking, regardless of their scores on the WGCTA.

Although it was embedded in the curriculum, Project Athena did not focus on student data regarding creative thinking; therefore, no student data involving this domain were available. However, the COS-R domain in creative thinking was also analyzed for patterns in teacher behavior for the study's teachers. Within the context of this study's small sample size, it can be said that gains made by teachers in creative thinking

substantiate the research that purports that creative thinking ability can be enhanced. These data are summarized by teacher and ATTA Creativity Index in Table 14.

Table 14

Creative Thinking- Teacher Data

Experimental Teacher	ATTA Creativity Index	COS-R Gain	COS-R Loss
1	2	1.0	0
2	6	.25	0
8	1	0	.17
9	5	.67	0
11	7	0	.50
13	7	.50	0
Comparison Teacher			
3	1	0	0
4	4	0	0
5	5	0	0
6	7	0	.33
10	7	0	.83
12	5	2.0	0
14	1	1.50	0
7	3	0	0
15	6	.75	0

More Project Athena experimental teachers (N=4), regardless of the Creativity Index obtained on the ATTA, increased behaviors which were likely to foster creative

thinking in the classroom as evidenced by the COS-R pre- post-observation data. However, two teachers decreased in their behaviors to foster creative thinking in the classroom; the ATTA Creativity Index level for these teachers ranged from a 1 (*minimal*) rating to a 7 (*substantial*) rating.

Some comparison teachers (N=4) remained constant in demonstrating behaviors which foster creative thinking in the classroom, regardless of the Creativity Index obtained on the ATTA. The COS-R ratings for these teachers neither increased nor decreased. One group of comparison teachers (N=3) showed an increase in teaching behaviors which foster creative thinking. These teachers ranged from a *minimal* (1) to *above average* (6) on the ATTA Creativity Index. Finally, two comparison teachers, both of whom scored *above average* (6) or *substantial* (7) on the ATTA Creativity Index, showed a decrease in teaching behaviors which foster creative thinking.

No discernable patterns emerged from this sub-analysis although in general teachers scoring high in critical thinking were observed to be using it more effectively in the classroom than did teachers scoring low on the critical thinking test. Student results on a test of critical thinking did not appear to be influenced by the teachers' scores on an instrument assessing the same construct.

An overall summary of teacher profiles for each dimension: WGCTA, ATTA, Years of Teaching, and Professional Development Hours was generated. The descriptive data show that of the teachers profiled, 60% of the teachers who scored low on the test of critical thinking also reported a low number of professional development hours. The 53% of teachers scoring high on a test of creative thinking reported both a low number of

professional development hours and a low number of years of service. The differences between experimental and comparison teachers were marginal across dimensions.

Each instrument's metric was examined and categorized as *high, medium, or low.* Teachers who scored in the 70th percentile or above on the WGCTA were considered in the high range; those who scored between the 35th and 69th percentiles were considered in the medium range, and those who scored in or below the 34th percentile were considered in the low range. The Abbreviated Torrance Test for Adults was similarly analyzed. Participants who generated a creativity level of five to seven were considered above average or high, a creativity level of four was considered average or medium, and a creativity level of three or below was considered below average or low. These rankings are in line with the ATTA Manual (Goff & Torrance, 2002).

Years of Teaching and Professional Development Hours reported were similarly categorized. Project Athena experimental and comparison teachers who participated in this study reported teaching experience from 1 to 28 years. Teachers who taught for 19-28 years were considered in the high range, while teachers who taught for 10-18 years were considered in the medium range. Teachers with less than ten years' experience were considered in the low range. Correspondingly, teachers who reported having experienced 62 or more hours of professional development within the past year were considered in the high range. Teachers who reported having experienced 30-60 hours of professional development were considered in the medium range, and teachers who reported having experienced less than 30 hours of professional development were considered in the low range. The professional development hours were based on the

licensure requirements of the state in which this study took place. These data are summarized in Table 15.

Table 15

Teacher Profile Summary of WGCTA, ATTA, Years of Teaching Experience, and Professional Development Hours by Experimental and Control Groups

Experimental Teacher	WGCTA	ATTA	Years Teaching Experience	Professional Development Hours
1	High	Low	Low	Low
2	High	High	Low	High
8	Low	Low	Low	Low
9	Low	High	Low	Low
11	Low	High	Low	Low
13	Low	High	High	Low
Comparison Teacher	WGCTA	ATTA	Years Teaching Experience	Professional Development Hours
3	High	Low	Medium	High
4	Medium	Medium	Medium	Low
5	Medium	High	Low	Medium
6	Medium	High	Low	Low
7	Low	Low	Medium	Low
10	Low	High	Low	Low
12	Low	High	High	Low
14	Low	Low	Medium	Low
15	Low	High	Low	Low

Finally a correlation was run to measure the relationship among these variables in the study. A positive and statistically significant relationship (r=.7) was found between scores on the WGCTA and the number of professional development hours experienced. which confirms the findings found in Table 15. At the time this study took place, two teachers were attempting to achieve National Board Certification, a process that required a minimum of 100 hours of professional development. These hours were reported by the teachers undergoing the process and may have impacted the correlational findings. The correlation data on these dimensions is summarized in Table 16.

Table 16

Correlations of Teacher Profile Dimensions

		WGCTA	ATTA	YRS	PD HRS
WGCTA	Pearson Correlation	1	-.232	-.067	.704**
	Sig. (2-tailed)		.406	.811	.003
	N	15	15	15	15
ATTA	Pearson Correlation	-.232	1	.105	.008
	Sig. (2-tailed)	.406		.710	.978
	N	15	15	15	15
YRS	Pearson Correlation	-.067	.105	1	-.098
	Sig. (2-tailed)	.811	.710		.729
	N	15	15	15	15
PD HRS	Pearson Correlation	.704**	.008	-.098	1
	Sig. (2-tailed)	.003	.978	.729	
	N	15	15	15	15

**Correlation is significant at the 0.01 level (2-tailed).

Summary of Findings Related to Research Questions

The research findings for the Wenglinsky Questionnaire, the Watson-Glaser Critical Thinking Assessment-Form S (WGCTA-S), the Abbreviated Torrance Test for Adults

(ATTA), Paul's protocol coding, and the interview emergent themes are summarized here by research question.

Findings related to Research Question #1.

Research Question #1 asked: Are there differences between experimental and comparison teachers participating in Project Athena with respect to training and experience in teaching critical thinking and other inputs of advanced learning that might affect the use of higher order thinking skills?

1) There appeared to be no significant or educationally important differences between the groups. In general, more similarities than differences were found:
    a) Both groups of teachers remained at the same grade level from one to five years.
    b) More teachers in both groups reported having experience in the 11-20 year range than any other range
    c) Both groups of teachers sought a greater number of hours of professional development outside of their districts.

Findings related to Research Question #2.

Research Question #2 probed the differences between experimental and comparison teachers by asking: What differences are there between experimental and comparison teachers participating in project Athena on a test of critical thinking?

1) Overall, experimental teachers averaged nine percentage points higher than comparison teachers on the Watson-Glaser Critical Thinking Assessment-Form S.

2) Experimental teachers were 12% more likely to determine the appropriateness of making assumptions, 5% more likely to make valid interpretations, and 6% more likely to evaluate the validity of arguments than were comparison teachers.

3) Comparison teachers were 5% more likely to recognize inferences than were experimental teachers.

Findings related to Research Question #3.

Research Question #3 asked: What differences exist among Project Athena teachers on a test of Creative Thinking?

1) A main difference is that experimental teachers (11%) were more likely to achieve a high (*above average, high, or substantial)* rating of creativity than were comparison teachers; however, both sets of teachers were well above the normalized standards in the substantial and above average ranges as published by Goff & Torrance (2002).

Findings related to Research Question #4.

Research Question #4 questioned: How do Project Athena experimental and comparison teachers define critical thinking?

Inductive analysis of interview responses suggest that the participants saw critical thinking as involving the provision of evidence or proof of one's thinking through analysis and the consideration of multiple perspectives in order to make relevant connections using skills such as discussion and questioning. Specific findings indicated that:

1) The majority of the participants (72%) had little or no concept of critical thinking.
2) The majority of the participants (58%) were able to articulate a limited conception of what constitutes critical thinking within a typical class day.
3) The majority of the participants (57%) had little or no conception of the difference between teaching by covering content versus teaching for enhancing critical thinking concepts.
4) Most of the participants interviewed (85%) were able to articulate a limited conception of important critical thinking skills as opposed to an elaborated concept of critical thinking.
5) The majority of the participants interviewed (57%) had a limited conception of what to look for when observing peers for indicators of teaching critical thinking.
6) Most of the participants (57%) had little or no conception of intellectual standards.
7) Most of the participants (42%) had little or no conception of the difference between an assumption and an inference.
8) Most of the participants (71%) had little or no conception of the difference between an inference and an implication.

Findings related to Research Question #5.

Research Question #5 asked: How are critical and creative thinking activities employed in these classrooms? Do they vary between experimental and comparison teachers?

There appeared to be little variance in the way experimental and comparison teachers employ critical and creative thinking activities in the classroom. Common ways in which these activities were employed included;

1) Ask students to provide support for their opinions;
2) Emphasize having students make connections to the real-world;
3) Use students' prior knowledge as a way to foster critical thinking in the classroom, and;
4) Ask students to consider alternate perspectives during classroom instruction.

Summary

Overall, the research findings suggest that experimental teachers sought professional development options that dealt with higher order thinking skills more regularly than did comparison teachers. Familiarity with higher order thinking skills may have enabled this group to achieve a slightly higher score on the Watson-Glaser Critical Thinking Assessment-Form S. Additional analysis of available Project Athena data indicated that there was no relationship between teachers' ability to think critically and scores on the COS-R. Experimental teachers participating in Project Athena were a highly creative group (66%) as evidenced by their high scores on the Abbreviated Torrance Test for Adults.

Neither experimental nor comparison teachers in this sample could fully articulate a concept of critical thinking, covering content and teaching critical thinking, intellectual standards and critical thinking, or the differences between assumptions and inferences as well as inferences and implications. However, in open-ended conversation, these teachers explained that requiring students to provide proof for their answers, having

students consider multiple perspectives, and providing students with opportunities to make relevant connections constituted ways in which critical thinking occurred in their classrooms.

The next chapter includes a more detailed discussion of the findings, conclusions regarding them, and suggested implications of the study for practice and further research.

Chapter 5
Discussion, Conclusions, and Implications

Introduction

The purpose of this study was to determine how well elementary language arts teachers participating in a federal project to raise students' critical thinking scored on tests of critical and creative thinking. Furthermore, it investigated the ways in which these teachers of the language arts have developed their understanding of critical thinking skills, what types of training they bring to the classroom which might enhance the teaching of critical thinking skills, and the methods by which they foster critical thinking in the classroom.

The study employed the following instruments to accomplish these purposes: the Wenglinsky Questionnaire, the Watson-Glaser Critical Thinking Assessment-Form S (WGCTA), the Abbreviated Torrance Test for Adults (ATTA), and Paul's interview protocol on critical thinking. Descriptive statistics, inductive analysis, and content analysis were the data analysis methods employed to interpret collected data.

Relevant strands of literature that provided the foundation for this study were found in the areas of critical thinking, creative thinking, and professional development. The discussion portion of this chapter, organized by the critical and creative thinking literature strands, emphasizes the relationship of research question findings to existing literature and to explorations generated from the study. The conclusion section includes a synthesis of findings by research question. Potential implications for policy, practice, and further research conclude the chapter.

Discussion

Critical Thinking

Project Athena experimental teachers scored nine percentage points higher than Project Athena comparison teachers on the Watson-Glaser Critical Thinking Assessment-Form S (WGCTA) and outperformed comparison teachers on four of five subtests on the WGCTA, substantiating the research which suggests that dispositions toward critical thinking can be improved upon through targeted instruction (Lang, 2001). This statement is further supported by the statistically significant and positive correlation (r = .7) of he relationship of professional development hours to high scores on the WGCTA. The training offered to experimental teachers by Project Athena using curriculum that focuses on how one thinks about concepts and themes inherent in learning language arts demonstrates the research connection between good curriculum and good teaching that contributes to the ability to demonstrate abstraction or conceptual thinking (Fisher, 2002).

Despite high scores on the WGCTA, increasingly high scores on the Classroom Observation Scales-Revised (COS-R), and the training provided by the Center for Gifted Education at the College of William and Mary, definitions of critical thinking articulated by these teachers during the interview process evidence that it is clearly an "honorific phrase . . . such that they feel obliged to claim both familiarity with it and commitment to it in their teaching" (Paul, Elder, & Bartell, 1997, p. 31). Across interview questions, teachers cited key phrases such as *higher order thinking skills* or the *upper levels of Bloom's Taxonomy* in their definitions of critical thinking. When probed for further information, these teachers could neither explain what higher order thinking skills they were citing nor could they define the upper levels of Bloom's Taxonomy by making

reference either to research-based indicators to expand their definitions or by citing a specific research-based definition of the construct.

Paul & Elder (1992) place great emphasis on the fact that critical thinkers must understand and apply the standards of reasoning in a routine matter; otherwise thinking processes remain narrow in scope. Their voices are echoes by others in the field who avow that critical thinkers use "a specific set of criteria to evaluate or judge something whether that something is a performance or an object" (Woodward, 2000, p. 32). Yet of the teachers interviewed, three demonstrated a limited conception of intellectual standards and four displayed little or no conception of the same topic. Teacher interviews showed evidence of teachers' beliefs that they are fostering critical thinking in the classroom, yet they fall short of the mark. Such beliefs included statements such as, "my students must have evidence and proof for everything." This statement implies that any evidence or proof, however poor, is acceptable. Similarly, the statement, "I am constantly making them look for information and make connections" implies that any manner in which one chooses to gather information or make connections is valid. Additionally, references to Bloom's taxonomy, cooperative learning, or multiple intelligences falsely equate the whole of critical thinking merely with a solitary model, not necessarily even related directly to critical thinking, substantiating the literature which purports that "asking students to evaluate a work, an idea, or a principle without knowledge of the criteria, procedures, and principles for making such determinations results in an unsubstantiated opinion or statement of preference, rather than an informed, well-founded judgment" (Parks, 2005, p.

252). Teacher gains on the COS-R and student gains on the TCT relative to this construct may be due to implementation of curriculum designed to address higher order thinking skills although the sample size was too small to accurately make such a generalization. These increased gains in critical thinking were consistent with scores generated over the three year implementation period by the Classroom Observation Scales-Revised (COS-R) in relation to teacher behaviors as well as the Test of Critical Thinking (TCT), the instrument used by Project Athena researchers to measure student gains regarding critical thinking.

Experimental teacher inputs, as evidenced by the Wenglinsky questionnaire, may reveal some rationale for these teachers' ability to score high on a test of critical thinking. Experimental teachers brought eight more years of teaching experience to the classroom than did comparison teachers. In addition to more years of teaching experience, experimental teachers tended to be somewhat more educated than comparison teachers, as 10% more of the experimental teachers responding to the questionnaire obtained master's degrees than did comparison teachers. However, this connection is tenuous at best as "the only teacher input that Wenglinsky found to make a difference in student achievement was the teacher's major or minor in a relevant subject" (Dixon & Moon, 2006, p. 571).

Wenglinsky (2000) found a strong connection between student achievement and professional development which focused on higher order thinking skills. The Wenglinsky questionnaire does not address critical thinking per se, but it does ask for information regarding professional development experiences involving both higher order thinking skills and gifted education, as "teachers with training in gifted education are

more likely to foster high-level thinking . . . and understand how to provide high end challenge" (NMSA/NAGC, 2004, p. 5). Both experimental and comparison teachers reported receiving an average of one day of district-mandated training in higher order thinking skills, and experimental teachers reported independently seeking a total of one day more (three days) than did comparison teachers (two days). Experimental teachers reported receiving an average of one-and-a-half days of district-mandated training in gifted education strategies, and they sought an additional three days of training in this area independently of their districts. Comparison teachers, on the other hand, reported receiving almost three days of gifted education strategies that were district-mandated and sought less than a half day's additional training independently.

It is difficult to make substantial generalizations based on the findings from this study with respect to the Wenglinsky Questionnaire. The instrument was chosen due to its usefulness in linking teacher inputs and professional development to student achievement. The instrument was not the optimal choice for use in this research study; however, due to a variety of reasons. First, the Wenglinsky Questionnaire focuses on all areas of professional development and is therefore not targeted specifically to tease out information primarily regarding critical thinking. It is too broad in scope to draw comparisons between experimental and comparison teachers' abilities to think and teach critically. Secondly, because this study focused more on teacher ability to think critically than on student achievement while the Wenglinksy Questionnaire was designed to measure a link between teacher inputs and student achievement, a methodological mismatch occurred. Finally, the researcher was naïve in thinking that the solution to the

issues posed by this study lay solely in the realm of professional development. If this study confirmed anything, it is that the business of teaching and learning is complex.

Creative Thinking

As a group, the sample consisted of a highly creative group of teachers. More experimental teachers than comparison teachers rated in the high range on the Abbreviated Torrance Test for Adults (ATTA), scoring more often in the *above average (Level 5), high (Level 6)*, and *substantial(Level 7)* ranges. These levels are determined by fluency, the ability to produce quantities of ideas relevant to a given task; originality, the ability to produce novel ideas; elaboration, the ability to add detail to one's ideas; and flexibility, the ability to manipulate ideas within the limitations of a given task (Torrance & Goff, 2002).

Elementary language arts teachers possess a specialized knowledge base (VanTassel-Baska, 1999; Cropley, 1999), concerned not only with skills inherent in the English language arts but also with pedagogical issues in elementary education. Strong ratings on the ATTA suggest that these highly creative teachers are exhibiting flexibility of thought by wielding specific areas of their subject area knowledge base with their pedagogical knowledge base in a manner which avoids limiting it to that which is conventional (Cropley, 1999). This high level of creativity was consistent with scores generated over the three year implementation period by the Classroom Observation Scales-Revised (COS-R), the instrument used by Project Athena researchers when observing teacher behaviors within the classroom.

Teachers in this sample also evidenced interpersonal tactics cited by Runco (1999) as creative behaviors. One such interpersonal tactic that emerged across interview

responses was arguing a perspective not one's own, a topic stressed in the William & Mary Language Arts Curriculum for High Ability Learners and used by experimental teachers during the implementation of Project Athena. One experimental teacher reported encouraging students to take others' perspectives not only for the practice of being able to step into another's shoes but also to promote understanding of a world outside their own. Another experimental teacher extends this idea to having students consider multiple perspectives in order to encourage students to discard personal assumptions and biases. Students who are able to take additional perspectives may be able to synthesize ideas which can lead to novel concepts and products (Kennedy, 2002).

Perspective plays an important role in linking creative and critical thinking, and it is a theme embedded in the data generated by this study. Some researchers posit that creativity exists solely as a support mechanism for critical thinking (Runco, 1999). The ability to recognize assumptions, an element of critical thinking (Paul, 1997), is based on one's perspective, a creative thinking interpersonal tactic (Runco, 1999) and could explain why, when teacher profiles were analyzed, 66% of the experimental teachers who were in the *above average* (Level 5), *high* (Level 6), or *substantial range* (Level 7) range on the ATTA scored 100% on recognizing assumptions while 50% of comparison teachers in these same ranges scored equally as well.

Some evidence exists that suggests that creative thinking abilities can be increased through training (Plucker & Beghetto, 2003; Plucker & Runco, 1999; Kolloff & Feldhusen, 1984). While training of experimental teachers did not specifically address creativity, several factors involved in the implementation of the program may have contributed to increasing creativity in these teachers, thus rendering high creativity

ratings on the ATTA. One factor is the overall flexibility of the curriculum itself. Rather than infusing artificial deadlines in the form of pacing guides into the curriculum, benchmarks are suggested so that individual differences may be addressed during unit implementation. Additionally, the William & Mary Curriculum for High Ability Learners is not a packaged program. Such programs sometimes lack creativity (Plucker & Beghetto, 2003) due to the fact that they rely largely on divergent thinking processes and neglect other areas of creativity. The William & Mary Language Arts Curriculum for High Ability Learners, on the other hand, emphasizes the study of literature connected to real-world situations and interdisciplinary connections which "creates new learning experiences and reinforces existing knowledge. The real-world nature . . . encourages students to take on specific roles" (Dixon & Moon, 2005, p.350), resulting in a sense of ownership in resultant products.

It is difficult to determine if the inputs these teachers bring to the classroom contribute to their high level of creativity or if their creativity is due more to a natural ability (Gagne, 1997). The Wenglinsky questionnaire does not overtly address creativity, and it is impossible to tell whether the areas of professional development experiences reported by participants included instruction in the ability to work autonomously, coaching on how to tolerate ambiguity, experience with being more open to stimuli, methods in deepening task commitment (Torrance, 1969; Renzulli, 1977; Amabile, 1996; VanTassel-Baska, 1998), or any other training which would enhance behaviors characteristic of creative thinking. Once again, the selection of the instrument utilized to uncover information on professional development was insufficient to probe the link between creativity and critical thinking.

A link between the professional development received by Project Athena experimental teachers as evidenced by higher scores in both the critical and creative thinking domains on the WGCTA, the ATTA, and the COS-R remains tenuous due to this study's small sample size. However, observation data from Project Athena's three year implementation period rendered evidence that the combination of recurring professional development, teacher support through innovative curriculum, and clarity of goals (VanTassel-Baska, 2007) contributed to higher gains for experimental teachers in the critical and creative thinking domains.

Additionally, teachers should be aware of their metacognitive processes with regard to critical and creative thinking because "knowledge of these characteristics and preferences and how they might effect [student] creativity ought to be a part of any curriculum" (Isaksen & Parnes, 1995, pg. 180). The importance of this awareness was highlighted by the teacher profile results. Three of the four teachers who showed profiles of high creativity and low critical thinking have been teaching for less than ten years. These teachers averaged 17 professional development hours during the past three academic years. According to the literature, research on "highly creative people suggest[s] that these people may not perform well on standardized measurements where one right answer is the only alternative (McCann, 2006, p. 4) such as is the case with the WGCTA. These teachers will be able to bring a multiplicity of novel ideas on which they may continue to elaborate to the classroom as long as the school culture and social interaction fit their needs (Carayannis & Gonzalez, 2003). They most likely do well with helping their students make interdisciplinary connections as "one of the factors that

contributes to the complexity of the conceptions of creativity is its interdisciplinary phenomenon" (Isaksen & Parnes, 1995, p. 171).

Two teachers, both with less than ten years of teaching experience, showed profiles which evidenced low creativity and high critical thinking abilities. These two teachers averaged 74 professional development hours. These teachers do well in environments in which using evidence and making deductions (Swartz & Perkins, 1990) are emphasized.

Conclusions

Findings from this study indicate that implementation of a targeted curriculum coupled with specific professional development may have some effect on teachers' use of critical thinking skills, although the sample size is too small to make that inference conclusively. Experimental teachers brought more years of experience to the classroom and participated in marginally more professional development experiences concerning higher order thinking skills and gifted education strategies than did comparison teachers. Experimental teachers scored higher on the Watson-Glaser Critical Thinking Assessment-Form S (WGCTA), outperforming comparison teachers on four of the five subtests which comprise the WGCTA. This superior performance may be due to an improvement in critical thinking dispositions as a result of the training offered by the Center for Gifted Education at the College of William and Mary through Project Athena. This training was sustained over a three year period and offered multiple resources tailored to teacher needs.

Because of its emphasis on dealing with issues involving perspective, the same training may have enhanced the creative thinking capabilities of Project Athena

experimental teachers as more experimental teachers than comparison teachers achieved *above average* (Level 5), *high* (Level 6), and *substantial* (Level 7) ratings on the Abbreviated Torrance Test for Adults than did comparison teachers.

Interview participants, a sub-sample of the group who took both the WGCTA and the ATTA, largely defined critical thinking in vague terms which paid homage to educational jargon, including terms like "Bloom's Taxonomy," "higher level thinking skills," etc. Both experimental and comparison teachers employed components of critical thinking in the classroom by demanding evidence or proof of one's thinking through considering multiple perspectives in order to make relevant connections, using such skills as discussion and questioning. However, teachers, in accepting student answers unsupported by critical thinking standards, confidently yet erroneously believed that they were fostering critical thinking.

Implications for Policy

Although the history of critical thinking dates back to the time of Socrates (Paul, 1997), encompassing well over 2500 years, there exists neither a common language nor a commonly accepted definition for this construct. The importance of "a set of paradigmatic practices that underlie the particular concepts and argument types characteristic of a discipline" (Weinstein, 1995, p. 7) or a language of the discipline cannot be understated. Teachers naturally seek a common language when they use terms like "Bloom's Taxonomy" and "higher order thinking skills" in attempting to articulate their definition of and describe classroom practices involving critical thinking. Adoption of a universally common language of critical thinking constructs would allow both teacher and student learners to cognitively organize concepts with clarity and precision as

well as to communicate those concepts to others in a highly effective manner. While adoption of a universal language of critical thinking was employed within the parameters of Project Athena's implementation, the results suggest that experimental teachers needed more time to deepen their understanding of the key terms of the Paul model.

Once a means of effective communication is in place, teacher preparation and teacher professional development experiences must be targeted to reconceptualize teacher practices regarding critical thinking. Such experiences must be accomplished so that teachers can then move from relying solely on disseminating procedures and information to conveying meaning and helping students make connections as developed by Ball & Cohen (1999) in the professional development literature. Furthermore, professional development experiences involving the development of critical thinking skills and dispositions and encompassing such topics as designing instruction to foster critical thinking skills must be sustained over time and accompanied by adequate resources, not only because of the complex relationships between critical thinking elements, but also because adequate time and resources are cited as essential indicators of successful professional development (Guskey, 2003).

Implications for Practice

Explicit implications in several areas of critical thinking, curriculum reform, and professional development stem from this study. First, teachers and students must be conversant in and have practice with the standards of reasoning across discipline content areas before they approach understanding and regular practice with the elements of reasoning. In order to foster a nation of critical thinkers, students must be taught from their first days of school to question materials, classmates, and teachers in compliance

with the standards of clarity, accuracy, precision, relevance, depth, breadth, logic, significance, fairness, and completeness (Paul, 1992). Students cannot be taught to be critical thinkers by teachers who are not practiced critical thinkers themselves. Therefore, "unless teacher education can prepare beginning teachers to learn to do much more thoughtful and challenging work, and unless ways can be found through professional development to help teachers sustain such work, traditional instruction is likely to persist . . ." (Ball & Cohen, 1999, p. 7).

Thompson & Zeuli (1999) suggest that a combination of teacher strategies is necessary to optimize critical thinking in the classroom. In addition to teacher knowledge regarding connections that students must make among relevant topics and the background students bring to the classroom, these researchers advocate for a model of teaching as a process by which teachers provoke students to think through correctly choosing or designing problems for their students to solve and allowing for extended engagement among students in order for such dialogue to take place. They suggest that in order for this to happen, a sufficiently high level of cognitive dissonance that is in some way connected to their students and teaching practice must be created in order for teachers' existing beliefs and practices to be questioned. This idea bolsters the argument that teacher professional development should be highly focued, collegially supported, and sustained over time.

A second implication concerns curriculum revision and reform which must be undertaken to include both the standards and elements of critical thinking as well as creative teaching and learning so that these constructs are not overlooked in favor of covering content. Discussion of and overt practice with the standards of reasoning as

well as the elements of reasoning, should be a routine part of curriculum units. Curriculum development emphasizing the standards serves to connect metacognitive functioning with the content being studied which would then enhance both teacher effectiveness and student production.

The William and Mary Language Arts Curriculum for High Ability Learners focuses on advanced knowledge development in the language arts; sustained capacity to focus; and the ability to use higher level and abstract thinking (VanTassel-Baska, 1995). Specifically, it highlights analytic and interpretive skills, persuasive writing skills, and reasoning skills using the overarching concept of change (Center for Gifted Education, 1988) and the deliberate use of instructional models to elicit higher order thinking skills. Implementation of this curriculum over a three year period showed that teachers grew in the dimensions of critical and creative thinking as measured by the Classroom Observation Scales-Revised (COS-R) and students grew with respect to critical thinking as measured by the Test of Critical Thinking (TCT). There is no guarantee that optimally developed curriculum will be properly implemented in the classroom setting; therefore, observable, measurable, and accountable indices of faculty behavior must be overseen and addressed through sustained professional development experiences such as those offered by Project Athena.

Yet that is not enough. Curriculum must be aligned to a universally accepted set of standards which foster the "capacity to think more clearly, more accurately, more precisely, more relevantly, more deeply, more broadly, and more logically" (Paul, 2000, p. 3). This implication for practice is aligned with Cohen & Ball (1999) who suggest that professional development could be improved by seeking ways to ground curriculum in

the tasks, questions, and problems of practice" (p. 20). Such alignment will assist in educating intellectually responsible citizens capable of dealing efficiently with global challenges through the use of critical thinking.

Implications for Further Research

The researcher expected the outcome of this study to indicate that an examination of teacher professional development practices would render positive insight into teacher abilities to articulate their definition of and rationale for higher order thinking skills. Unfortunately, the Wenglinsky Questionnaire, chosen to track hours of professional development with respect to critical and creative thinking instruction, was too broad in nature to delve sufficiently into this issue. Future studies should involve an instrument whose aim is to delve into teacher development with respect to critical thinking as linked to professional development experiences instead of one which links student achievement to teacher inputs, as in the case of the Wenglinksy Questionnaire.

Similarly, Paul's protocol yielded the opposite result by being too narrow in scope for the purposes of this study. Paul's protocol relies heavily on strict language embedded in his model of critical thinking. Comparison teachers responding to questions in Paul's protocol who had no experience with his model were immediately relegated to the *having no concept* or *having a limited* concept of critical thinking. A future study might pilot a question protocol designed specifically to investigate teacher concepts of critical thinking by linking them more closely to practice in the K-12 arena.

There is some evidence that the more professional development teachers receive in working with special populations, the less likely they are to engage in lower-order activities (Wenglinsky, 2004). Broadening the scope of this exploratory study from

specifically critical thinking to other types of higher order thinking by investigating professional development activities in problem solving or other meaningful hands-on activities and other kinds of higher order thinking might be the starting point for such a study.

In Conclusion

At the time this study was being conducted, the national mandate of the *No Child Left Behind* legislation had enjoyed six years of active implementation. Because each state is responsible for implementation of this legislation in its own manner and because achievement of a 70% pass rate holds meanings as diverse as this nation's regions, it cannot be assured that critical and creative thinking have not given way to factual recall and rote memorization, not to mention teaching-to-the-test. Clearly, however, it is apparent that national crises such as the response time and aftermath of Hurricane Katrina as well as global issues such as President Bush's War on Iraq cannot be solved by consulting a checklist of sequentially given steps. Therefore, it is tantamount that teachers offer their students manifold opportunities to learn to think and therefore problem solve in the real world and scaffold these opportunities as the consequences are dire if they do not. Critical and creative thinking must retake center stage in involving the acts of teaching and learning.

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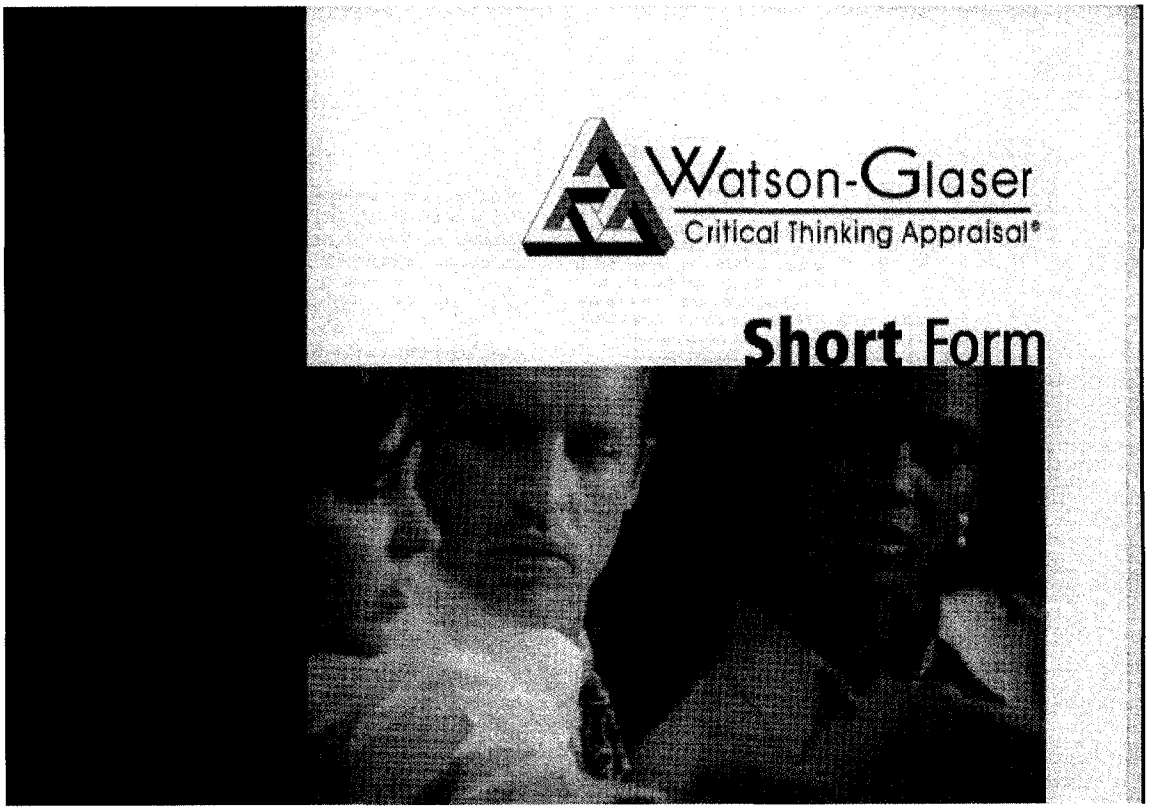
Appendix A
Watson-Glaser Critical Thinking Appraisal-Short Form



Appendix A
Watson-Glaser Critical Thinking Appraisal-Short Form

TEST 1: INFERENCE

DIRECTIONS

An inference is a conclusion a person can draw from certain observed or supposed facts. For example, if the lights are on in a house and music can be heard coming from the house, a person might infer that someone is at home. But this inference may or may not be correct. Possibly the people in the house did not turn the lights and the radio off when they left the house.

In this test, each exercise begins with a statement of facts that you are to regard as true. After each statement of facts you will find several possible inferences—that is, conclusions that some persons might draw from the stated facts. Examine each inference separately and make a decision as to its *degree* of truth or falsity.

For each inference you will find spaces on the answer sheet labeled **T, PT, ID, PF,** and **F.** For each inference make a mark on the answer sheet under the appropriate heading as follows:

T if you think the inference is definitely **TRUE;** that it properly follows beyond a reasonable doubt from the statement of facts given.

PT if, in the light of the facts given, you think the inference is **PROBABLY TRUE;** that it is more likely to be true than false.

ID if you decide that there are **INSUFFICIENT DATA;** that you cannot tell from the facts given whether the inference is likely to be true or false; if the facts provide no basis for judging one way or the other.

PF if, in the light of the facts given, you think the inference is **PROBABLY FALSE;** that it is more likely to be false than true.

F if you think the inference is definitely **FALSE;** that it is wrong, either because it misinterprets the facts given, or because it contradicts the facts or necessary inferences from those facts.

Sometimes, in deciding whether an inference is probably true or probably false, you will have to use certain commonly accepted knowledge or information that practically every person has. This will be illustrated in the example that follows.

Look at the example in the next column; the correct answers are indicated in the block at the right.

EXAMPLE

Two hundred students in their early teens voluntarily attended a recent weekend student conference in a Midwestern city. At this conference, the topic of race relations and means of achieving lasting world peace were discussed, since these were the problems the students selected as being most vital in today's world.

	Test 1				
	T	PT	ID	PF	F
1	○	●	○	○	○
2	○	○	○	●	○
3	○	○	●	○	○
4	○	○	○	○	●
5	●	○	○	○	○

1. As a group, the students who attended this conference showed a keener interest in broad social problems than do most other students in their early teens.
2. The majority of the students had not previously discussed the conference topics in their schools.
3. The students came from all sections of the country.
4. The students discussed mainly labor relations problems.
5. Some teenage students felt it worthwhile to discuss problems of race relations and ways of achieving world peace.

In the above example, inference 1 is probably true **(PT)** because (as is common knowledge) most people in their early teens do not show so much serious concern with broad social problems. It cannot be considered definitely true from the facts given because these facts do not tell *how much* concern other young teenagers may have. It is also possible that some of the students volunteered to attend mainly because they wanted a weekend outing.

Inference 2 is probably false **(PF)** because the students' growing awareness of these topics probably stemmed at least in part from discussions with teachers and classmates.

There is no evidence for inference 3. Thus, there are insufficient data **(ID)** for making a judgment on the matter.

Inference 4 is definitely false **(F)** because it is given in the statement of facts that the topics of race relations and means of achieving world peace were the problems chosen for discussion.

Inference 5 necessarily follows from the given facts; it therefore is true **(T).**

In the exercises that follow, more than one of the inferences from a given statement of facts may be true **(T),** or false **(F),** or probably true **(PT),** or probably false **(PF),** or have insufficient data **(ID)** to warrant any conclusion. Thus, you are to judge each inference independently.

Make a heavy black mark in the space under the heading that you think best describes each inference. If you change an answer, erase it thoroughly. Make no extra marks on the answer sheet.

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Appendix A
Watson-Glaser Critical Thinking Appraisal-Short Form

EXERCISES

In 1946 the United States Armed Forces conducted an experiment called "Operation Snowdrop" to find out what kinds of military personnel seemed to function best under severe arctic climatic conditions. Some of the factors examined were weight, age, blood pressure, and national origin. All of the participants in "Operation Snowdrop" were given a training course in how to survive and function in extreme cold. At the conclusion of the experiment, it was found that only two factors among those studied distinguished between personnel whose performance was rated as "effective" and those rated as "not effective" on the arctic exercises. These factors were: (1) desire to participate in the experiment, and (2) degree of knowledge and skill regarding how to live and protect oneself under arctic conditions.

1. Despite the training course given to all of the participants in "Operation Snowdrop," some participants exhibited greater arctic survival knowledge or skill than others.
2. It was believed by the Armed Forces that military operations might someday be carried out in an arctic-like environment.
3. A majority of the personnel who participated in "Operation Snowdrop" thoroughly disliked the experience.
4. Participants having normal weight and blood pressure were rated as significantly more effective on the arctic exercises than were the other participants.

Some time ago a crowd gathered in Middletown to hear the new president of the local Chamber of Commerce speak. The president said, "I am not asking, but demanding, that labor unions now accept their full share of responsibility for civic improvement and community welfare. I am not asking, but demanding, that they join the Chamber of Commerce." The members of the Central Labor Unions who were present applauded enthusiastically. Three months later all the labor unions in Middletown were represented in the Chamber of Commerce. These representatives worked with representatives of other groups on committees, spoke their minds, participated actively in the civic improvement projects, and helped the Chamber reach the goals set in connection with those projects.

5. Both the labor union representatives and the other members of the committees came to a better recognition of one another's viewpoints through their Chamber of Commerce contacts.
6. Union participation in the Middletown Chamber of Commerce greatly reduced worker-management disputes in that town.
7. Most of the union representatives regretted having accepted the invitation to participate in the Chamber of Commerce.

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Appendix A
Watson-Glaser Critical Thinking Appraisal-Short Form

TEST 2: RECOGNITION OF ASSUMPTIONS

DIRECTIONS

An assumption is something presupposed or taken for granted. When you say, "I'll graduate in June," you take for granted or assume that you will be alive in June, that your school will judge you to be eligible for graduation in June, and similar things.

Below are a number of statements. Each statement is followed by several proposed assumptions. You are to decide for each assumption whether a person, in making the given statement, is really making that assumption — that is, taking it for granted, justifiably or not.

If you think that the given assumption is taken for granted in the statement, make a heavy black mark under "**ASSUMPTION MADE**" in the proper place on the answer sheet. If you think the assumption is *not* necessarily taken for granted in the statement, blacken the space under "**ASSUMPTION NOT MADE.**" Remember to judge each assumption independently.

Below is an example. The block at right shows how these items should be marked on the answer sheet.

EXAMPLE

Statement: "We need to save time in getting there so we'd better go by plane."

Proposed Assumptions:

1. Going by plane will take less time than going by some other means of transportation. (It is assumed in the statement that the greater speed of a plane over the speeds of other means of transportation will enable the group to reach its destination in less time.)
2. There is plane service available to us for at least part of the distance to the destination. (This is necessarily assumed in the statement since, in order to save time by plane, it must be possible to go by plane.)
3. Travel by plane is more convenient than travel by train. (This assumption is not made in the statement—the statement has to do with saving time, and says nothing about convenience or about any other specific mode of travel).

Test 2	Assumption Made	Assumption Not Made
1	●	○
2	●	○
3	○	●

EXERCISES

Statement: "Zenith is the city to move to – it has the lowest taxes."

Proposed assumptions:

8. Lower taxes imply efficient city management.
9. In deciding where to live, it is important to avoid high taxes.
10. The majority of the residents in Zenith are content with their present city government.

Statement: "I'm traveling to South America. I want to be sure that I do not get typhoid fever, so I shall go to my physician and get vaccinated against typhoid fever before I begin my trip."

Proposed assumptions:

11. If I don't take the injection, I shall become ill with the fever.
12. By getting vaccinated against typhoid fever, I decrease the chances that I will get the disease.
13. Typhoid fever is more common in South America than it is where I live.

Statement: "If war is inevitable, we'd better launch a preventive war now while we have the advantage."

Proposed assumptions:

14. If we fight now, we are more likely to win than we would be if forced to fight later.
15. If we don't launch a preventive war now, we'll lose any war that may be started by an enemy later.

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Appendix A
Watson-Glaser Critical Thinking Appraisal-Short Form

TEST 3: DEDUCTION

DIRECTIONS

In this test, each exercise consists of several statements (premises) followed by several suggested conclusions. *For the purposes of this test, consider the statements in each exercise as true without exception.* Read the first conclusion beneath the statements. If you think it *necessarily follows* from the statements given, make a heavy black mark under "CONCLUSION FOLLOWS" in the proper place on the answer sheet. If you think it is *not a necessary conclusion* from the statements given, put a heavy black mark under "CONCLUSION DOES NOT FOLLOW," even though you may believe it to be true from your general knowledge.

Likewise, read and judge each of the other conclusions. Try not to let your prejudices influence your judgment - just stick to the given statements (premises) and judge each conclusion as to whether it *necessarily* follows from them.

The word "some" in any of these statements means an indefinite part or quantity of a class of things. "Some" means *at least* a portion, and *perhaps* all of the class. Thus, "Some holidays are rainy" means *at least* one, possibly more than one, and *perhaps* even all holidays are rainy.

Study the example carefully before starting the test.

EXAMPLE

Some holidays are rainy. All rainy days are boring. *Therefore* —

1. No clear days are boring. (The conclusion does not follow. You cannot tell from the statements whether or not clear days are boring. Some may be).
2. Some holidays are boring. (The conclusion necessarily follows from the statements since, according to them, the rainy holidays must be boring.)
3. *Some holidays are not boring.* (The conclusion does not follow, even though you may know that some holidays are very pleasant.)

Test 3	Conclusion	
	Follows	Does Not Follow
1	○	●
2	●	○
3	○	●

EXERCISES

No person who thinks scientifically places any faith in the predictions of astrologers. Nevertheless, there are many people who rely on horoscopes provided by astrologers. Therefore -

16. People who lack confidence in horoscopes think scientifically.
17. Many people do not think scientifically.

All members of symphony orchestras enjoy playing classical music. All members of symphony orchestras spend long hours practicing. Therefore -

18. Musicians who play classical music do not mind spending long hours practicing.
19. Some musicians who spend long hours practicing enjoy playing classical music.

Rice and celery must have a good deal of moisture in order to grow well, but rye and cotton grow best where it is relatively dry. Rice and cotton grow where it is hot, and celery and rye where it is cool. In Timbuktu, it is very hot and damp. Therefore -

20. Neither the temperature nor the moisture conditions in Timbuktu are favorable for growing a celery crop.
21. The temperature and moisture conditions in Timbuktu are more favorable for growing rice than for growing celery, cotton, or rye.
22. Conditions in Timbuktu are not altogether favorable for growing a cotton or a rye crop.

Most persons who attempt to break their smoking habit find that it is something that they can accomplish only with difficulty, or cannot accomplish at all. Nevertheless, there is a growing number of individuals whose strong desire to stop smoking has enabled them to break the habit permanently. Therefore -

23. Only smokers who strongly desire to stop smoking will succeed in doing so.
24. A strong desire to stop smoking helps some people to permanently break the habit.

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TEST 4: INTERPRETATION

DIRECTIONS

Each exercise below consists of a short paragraph followed by several suggested conclusions.

For the purpose of this test, assume that everything in the short paragraph is true. The problem is to judge whether or not each of the proposed conclusions logically follows beyond a reasonable doubt *from the information given in the paragraph.*

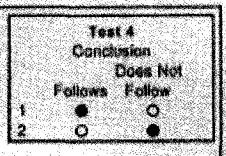
If you think that the proposed conclusion follows beyond a reasonable doubt (even though it may not follow absolutely and necessarily), then make a heavy black mark under "CONCLUSION FOLLOWS" in the proper place on the answer sheet. If you think that the conclusion does *not* follow beyond a reasonable doubt from the facts given, then blacken the space under "CONCLUSION DOES NOT FOLLOW." Remember to judge each conclusion independently.

Look at the example below; the block at the right shows how the answers should be marked on the answer sheet.

EXAMPLE

A study of vocabulary growth in children from eight months to six years old shows that the size of spoken vocabulary increases from zero words at age eight months to 2562 words at age six years.

1. None of the children in this study had learned to talk by the age of six months. (The conclusion follows beyond a reasonable doubt since, according to the statement, the size of the spoken vocabulary at eight months was zero words.)
2. Vocabulary growth is slowest during the period when children are learning to walk. (The conclusion does not follow since there is no information given that relates growth of vocabulary to walking.)



EXERCISES

When the United States Steel Corporation was created in 1902, it was the largest corporation America had known up to that time. It produced twice as much steel as all of its domestic competitors put together. Today, the United States Steel Corporation produces about 20 percent of the steel that is made in this country.

25. In 1902, the United States Steel Corporation produced not less than 66 percent of the total domestic output of steel.
26. Today, domestic competitors produce more than three times as much steel as does the United States Steel Corporation.
27. The United States Steel Corporation produces less steel today than it did in 1902.

Pat had poor posture, had very few friends, was ill at ease in company, and in general was very unhappy. Then, a close friend recommended that Pat visit Dr. Baldwin, a reputed expert on helping people improve their personalities. Pat took this recommendation and, after three months of treatment by Dr. Baldwin, developed more friendships, was more at ease, and in general felt happier.

28. Without Dr. Baldwin's treatment, Pat would not have improved.
29. Without a friend's advice, Pat would not have heard of Dr. Baldwin.

When I go to bed at night, I usually fall asleep quite promptly. But about twice a month I drink coffee during the evening, and whenever I do, I lie awake and toss for hours.

30. My problem is mostly psychological; I expect that the coffee will keep me awake and therefore it does.
31. On nights when I want to fall asleep promptly, I'd better not drink coffee in the evening.

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Appendix A
Watson-Glaser Critical Thinking Appraisal-Short Form

TEST 5: EVALUATION OF ARGUMENTS

DIRECTIONS

In making decisions about important questions, it is desirable to be able to distinguish between arguments that are strong and arguments that are weak, as far as the question at issue is concerned. *For an argument to be strong, it must be both important and directly related to the question.*

An argument is weak if it is not directly related to the question (even though it may be of great general importance), or if it is of minor importance, or if it is related only to trivial aspects of the question.

Below is a series of questions. Each question is followed by several arguments. *For the purpose of this test, you are to regard each argument as true.* The problem then is to decide whether it is a *strong* or a *weak* argument.

Make a heavy black mark on the answer sheet under **"ARGUMENT STRONG"** if you think the argument is *strong*, or under **"ARGUMENT WEAK"** if you think the argument is weak. Judge each argument separately on its own merit. *Try not to let your personal attitude toward the question influence your evaluation of the argument, since each argument is to be regarded as true.*

In the example, note that the argument is evaluated as to how well it supports the side of the question indicated.

EXAMPLE

Should all young men in the United States go to college?

Test 5	Argument	
	Strong	Weak
1	○	●
2	●	○
3	○	●

1. Yes; college provides an opportunity for them to learn school songs and cheers. (This would be a silly reason for spending years in college.)
2. No; a large percent of young men do not have enough ability or interest to derive any benefit from college training. (If this is true, as the directions require us to assume, it is a weighty argument against all young men going to college.)
3. No; excessive studying permanently warps an individual's personality. (This argument, although of great general importance when accepted as true, is not directly related to the question, because attendance at college does not necessarily require excessive studying.)

When the word "should" is used as the first word in any of the following questions, its meaning is, "Would the proposed action promote the general welfare of the people in the United States?"

EXERCISES

Should groups in this country who are opposed to some of our government's policies be permitted unrestricted freedom of press and speech?

32. Yes; a democratic state thrives on free and unrestricted discussion, including criticism.
33. No; the countries opposed to our form of government do not permit the free expression of our points of view in their territories.

Should the United States Department of Defense keep the public informed of its anticipated scientific research programs by publicizing ahead of time the needs that would be served by each program?

34. No; some become critical of the government when widely publicized projects turn out unsuccessfully.
35. Yes; only a public so informed will support vital research and development activities with its tax dollars.

Do juries decide court cases fairly when one of the opposing parties is rich and the other is poor?

36. No; because rich people are more likely to settle their cases out of court.
37. No; most jurors are more sympathetic to poor people than to the rich, and the jurors' sympathies affect their findings.
38. No; because rich people can afford to hire better lawyers than poor people, and juries are influenced by the skill of the opposing lawyers.

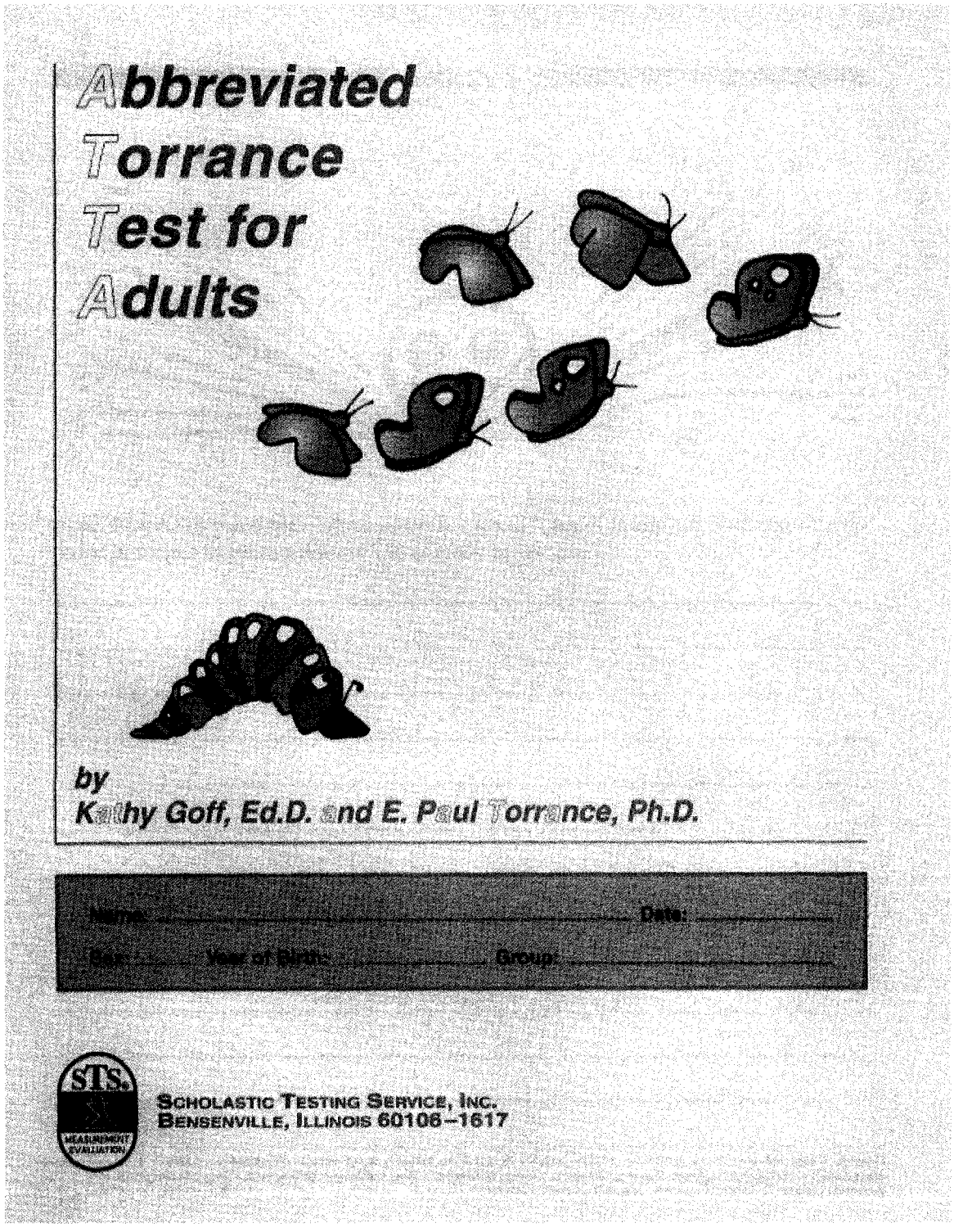
Should pupils be excused from public schools to receive religious instruction in their own churches during school hours?

39. No; having public school children go off to their separate churches during school hours would seriously interfere with the educational process and create friction among children of different religions.
40. No; religious instruction during school hours would violate our constitutional separation of church and state; those who desire such instruction are free to get it after school hours.

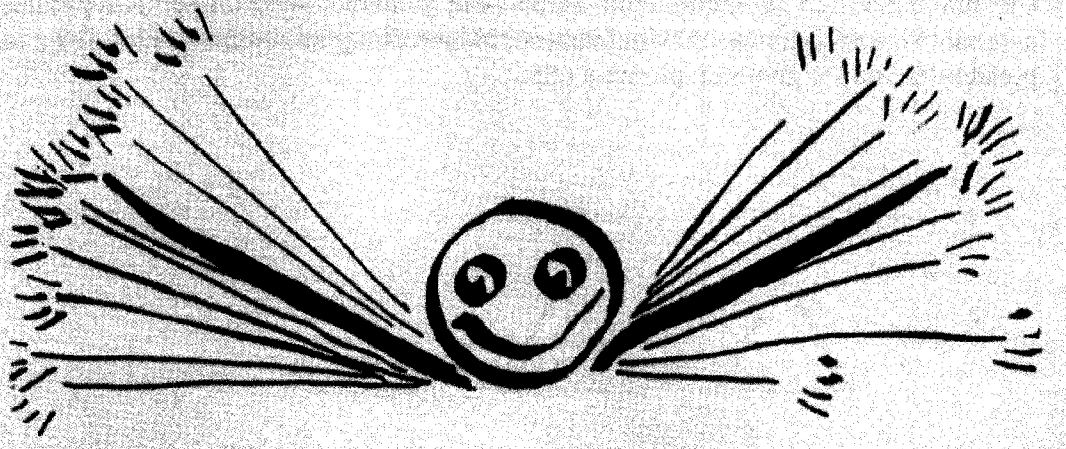
STOP.

You may go back and check your work.

Appendix B
Abbreviated Torrance Test for Adults



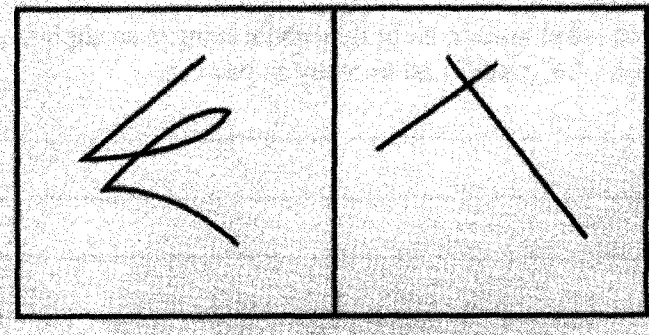
Activity 1



JUST SUPPOSE you could walk on air or fly without being in an airplane or similar vehicle. What problems might this create? List as many as you can.

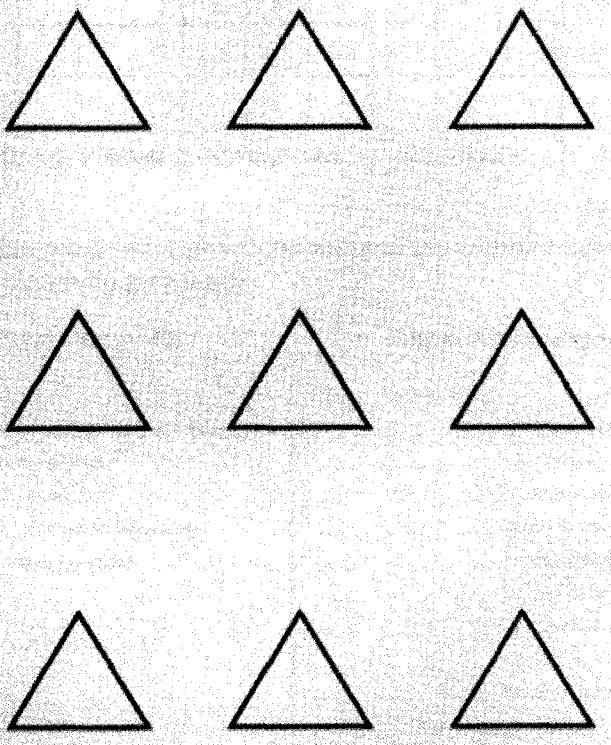
Activity 2

Use the incomplete figures below to make some pictures. Try to make your pictures unusual. Your pictures should communicate as interesting and as complete a story as possible. Be sure to give each picture a title.



Activity 3

See how many objects or pictures you can make from the triangles below, just as you did with the incomplete figures. Remember to create titles for your pictures.



Appendix B
Abbreviated Torrance Test for Adults

Abbreviated Torrance Test for Adults (ATTA)
Scoring/Interpretation Worksheet

Name _____ Age (yrs.) _____ Group _____ Date _____

Norm-Referenced Measures

Creative Ability	Raw Scores: Activity 1	Activity 2	Activity 3	Total Score	Scaled Scores: 11	12	13	14	15	16	17	18	19	Scaled Scores
					Corresponding Raw Scores									
Fluency					1–6	7	8–9	10	11–12	13–14	15–16	17	18+	
Originality					1	2	3	4	5	6	7–8	9–10	11+	
Elaboration	X				1–3	4–5	6–8	9–11	12–14	15–18	19–23	24–27	28+	
Flexibility	X	X			–	1	–	2	3	–	4	5	6+	
			Creative Roles:		Collaborator			Contributor			Accelerator			
													Total Scaled Score	

Criterion-Referenced Creativity Indicators

Verbal Responses (Activity #1)

Tally	Rating	Raw Score	
____	____	____	1. Richness and Colorfulness of Imagery
____	____	____	2. Emotions/Feelings
____	____	____	3. Future Orientation
____	____	____	4. Humor: Conceptual Incongruity
____	____	____	5. Provocative Questions
	Total	____	

Figural Responses (Activities #2 and #3)

Tally	Rating	Raw Score	
____	____	____	6. Openness: Resistance to Premature Closure
____	____	____	7. Unusual Visualization, Different Perspective
____	____	____	8. Movement and/or Sound
____	____	____	9. Richness and/or Colorfulness of Imagery
____	____	____	10. Abstractness of Titles
____	____	____	11. Articulateness in Telling Story
____	____	____	12. Combination/Synthesis of Two or More Figures
____	____	____	13. Internal Visual Perspective
____	____	____	14. Expressions of Feelings and Emotions
____	____	____	15. Fantasy
	Total	____	

Composite Measures

____ Total Scaled Score
\+ ____ Total Indicator Score (Count 1-point for each "+" and 2 for each "++")
= ____ CREATIVITY INDEX (CI)

*Creativity Index**	1–50	51–59	60–67	68–73	74–77	78–84	85+
Creativity Level	1	2	3	4	5	6	7
Verbal Assessment	Minimal	Low	Below Average	Average	Above Average	High	Substantial
% of Adults in Level	4%	12%	20%	26%	20%	12%	4%

*Interpretive Aid–Find Creativity Index in top row score range. Use information in that column to help understand the CI.

Appendix C
Wenglinksy's Inputs/Activities Questionnaire

Current teaching assignment (Grade level & Subject)_____

Number of students identified gifted _____

In the past year, how many of the following types of professional development have you attended that were offered by your district?

Assessment	Number of days _____
Content	Number of days _____
Cooperative Learning	Number of days _____
Educational Technology	Number of days _____
Teaching Methods	Number of days _____
Diverse student populations	Number of days _____
Classroom Management	Number of days _____
Higher-order thinking skills	Number of days _____
Interdisciplinary instruction	Number of days _____
Gifted Education	Number of days _____

In the past year, how many of the following types of professional development have you sought independently of your district?

Assessment	Number of days _____
Content	Number of days _____
Cooperative Learning	Number of days _____
Educational Technology	Number of days _____
Teaching Methods	Number of days _____
Diverse student populations	Number of days _____
Classroom Management	Number of days _____
Higher-order thinking skills	Number of days _____
Interdisciplinary instruction	Number of days _____
Gifted Education	Number of days _____

Appendix D
Richard Paul's Interview Protocol

1. What subjects do you teach most regularly?
2. What would you identify as your specialty or domain of highest expertise?
3. Have you read any articles or books or attended any conferences on critical thinking in the last five years?

4. How important is critical thinking to your instructional objectives?
   (a) of little or small importance
   (b) of secondary importance
   (c) of primary importance

5. My concept of critical thinking is largely:
   (d) intuitive in my thinking, or
   (e) explicit in my thinking

6. My concept of critical thinking is largely:
   (f) a product of my own thinking
   (g) a product of one or more particular theories of critical thinking to which I explicitly subscribe

7. In your concept of critical thinking do you explicitly distinguish critical thinking skills and traits?
   (h) yes
   (i) no

8. In your view, do you think of knowledge, truth, and sound judgment as:

   (j) not fundamentally a matter of my own personal preference or subjective taste or,

   (k) fundamentally, a matter of my own personal preference or subjective taste

9. Would you say that your department or school has a shared approach to the teaching of critical thinking or is it left more or less to individual faculty members' discretion to decide whether and how they approach critical thinking?

   (l) yes, a shared approach

   (m) no, left to individual faculty

10. In your view, how important is it for students to acquire sound intellectual criteria or standards to use in the assessment of their own thinking and the thinking of others?

    (n) of little or small importance

    (o) of secondary importance

    (p) of primary importance

11. In your view, how important is it for students to learn how to assess their own work?

    (q) of little or small importance

    (r) of secondary importance

    (s) of primary importance

12. Do you feel that students generally come to your classes with well developed intellectual standards or criteria to use in assessing thinking?

    (t) in general, yes

    (u) in general, no

13. Which of the following four descriptions best represents your assessment of the degree to which your school's students develop the ability to think critically as a result of their course work?

    (v) little or no development of critical thinking ability

    (w) a low level of the development of critical thinking ability

    (x) a good level of development of critical thinking ability

    (y) a high level of development of critical thinking ability

14. Which of the following four descriptions best represents your assessment of the degree to which your school's graduates develop the knowledge and ability to foster critical thinking in their future students?

    (z) little or no development of such knowledge and ability

    (aa) a low level of the development of such knowledge and ability

    (bb) a good level of development of such knowledge and ability

    (cc) a high level of development of such knowledge and ability

Beginning of open-ended questions:

15. Would you explain to me your concept of critical thinking? Perhaps you could begin by completing the following sentence: "To me, critical thinking is _____"
16. Is there anything you do on a daily basis in the classroom that you believe fosters critical thinking?
17. Some faculty feel they have too much content to cover to have much time left for fostering critical thinking. What is your view of this position?
18. What particular critical thinking skills do you believe are most important for your students to develop?
19. If you had the task of assessing the extent to which some faculty member was or was not emphasizing or fostering critical thinking through his or her instruction, how would you go about making that assessment?
20. What is your personal conception of intellectual criteria or standards?

21. How would you explain the difference between an assumption and an inference?

22. How would you explain the difference between an inference and an implication?

Appendix E
Richard Paul's Coding Sheet for Open-Ended Questions

Interviewee_____ Time_____ Date_____

Coder_____ Tape Number_____

(12) **Concept of Critical Thinking**

- Some **vagueness** in answer o
- Some **misconception** in answer o
- **Wanders** from question o
- **Contradiction** in answer (or in relation to another answer) o

(a) **little** or no conception
(b) **limited** conception
(c) **elaborated** conception

_____

_____

_____

_____

_____

_____

_____

(13) Description of typical day in class that fosters critical thinking

- Some **vagueness** in answer o
- Some **misconception** in answer o
- **Wanders** from question o
- **Contradiction** in answer (or in relation to another answer) o

(a) **little** or no conception
(b) **limited** conception
(c) **elaborated** conception

---

(16) **How one would assess the extent to which a faculty member was/was not fostering critical thinking?**

- Some **vagueness** in answer o
- Some **misconception** in answer o
- **Wanders** from question o
- **Contradiction** in answer (or in relation to another answer) o

(d) **little** or no conception
(e) **limited** conception
(f) **elaborated** conception

---

(17) Your personal conception of intellectual standards.

- Some **vagueness** in answer o
- Some **misconception** in answer o
- **Wanders** from question o
- **Contradiction** in answer (or in relation to another answer) o

(g) **little** or no conception
(h) **limited** conception
(i) **elaborated** conception

---

(18) **Difference between assumption and inference**

- Some **vagueness** in answer o
- Some **misconception** in answer o
- **Wanders** from question o
- **Contradiction** in answer (or in relation to another answer) o

(j) **little** or no conception
(k) **limited** conception
(l) **elaborated** conception

(19) **Difference between inference and implication**

- Some **vagueness** in answer o
- Some **misconception** in answer o
- **Wanders** from question o
- **Contradiction** in answer (or in relation to another answer) o

(m)**little** or no conception
(n) **limited** conception
(o) **elaborated** conception

Appendix E
Richard Paul's Coding Sheet for Open-Ended Questions

The interviewee did/did not mention the following:

(1) **basic skills of thought**. . . .such as clarifying the question; gathering relevant data

or information; formulating or reasoning to logical or valid conclusions, interpretations, or solutions; identifying key assumptions, tracing significant implications, entering accurately into alternative viewpoints. . . .

not at all minimal or vague allusion mentioned elaborated

Comment

---

(2) **important intellectual traits of mind**. . . .such as intellectual humility, intellectual perseverance, intellectual responsibility, intellectual integrity, and fairmindedness. . .

not at all minimal or vague allusion mentioned elaborated

Comment

---

(3) teaching to facilitate **reasoning within the subject**. . .teaching for historical thinking, sociological thinking, mathematical thinking, biological thinking, scientific thinking, philosophical thinking. . .

not at all minimal or vague allusion mentioned elaborated

Comment

---

(4) **an emphasis on problem solving**

not at all minimal or vague allusion mentioned elaborated

Comment

---

(5) the **special need for critical thinking today** in virtue of such phenomena as accelerating change, intensifying complexity, and increasing interdependence (or analogous phenomena)

not at all minimal or vague allusion mentioned elaborated

Comment

---

(6) **the need for a greater emphasis on peer and student self-assessment**

not at all minimal or vague allusion mentioned elaborated

Comment

Appendix F
Axial Codes for Emergent Themes from Interviews

Concept of Critical Thinking

Deep explanation or analysis (G)

Work through an issue, situation, or problem (D)

Appropriate conclusion (D)

Break it apart (E)

Look at causes (E)

Why things happen (E)

Use higher level questions (E)

Tear it apart (A)

Examine (E)

Evidence or perspective (E)

Deep, not surface (E)

Put aside assumptions (F)

Judge (F)

Multiple perspectives (F)

Fostering Critical Thinking in the Classroom

Why-for elaboration (A)

Make connections (C)

Personal connections (C)

Make inferences (C)

Discussion (B)

Student-generated questions (B)

Make connections to prior knowledge (B)

Appendix F
Axial Codes for Emergent Themes from Interviews

Relate to self (B)

Use of context clues (E)

Issue based discussion (F)

Passionate topic (F)

Connected to daily life (F)

Self check (G)

Work with partners (G)

Reconciling covering content with teaching critical thinking

Not separate; weave together (A)

Cover content through open discussion (D)

Connect to prior knowledge (D)

Very pushed to cover content (C)

Can't understand content without critical thinking (F)

Cover with critical thinking (G)

Have to make time (E)

Has to be a priority (E)

Tend to get bogged down in content (B)

Some critical thinking (B)

Worried about tests (B)

Important Critical Thinking Skills to Teach

Perspective (B)

Empathy (B)

Understanding of the world (B)

Appendix F
Axial Codes for Emergent Themes from Interviews

Express one's own opinion (B)

Support one's own opinion (B)

Persuade others (B)

Analyze (D)

Question (D)

Provide evidence and proof (D)

Application of information (E)

Question authority (E)

Use imagination (E)

Unbiased look at one's own work (F)

Justify a process (F)

Provide evidence for an argument (A)

Observation of another classroom

Question the student-teacher ratio of speaking (C)

Types of questions teacher asks (C)

Restating (C)

Probing (C)

Discussion versus written response (B)

Connect to prior knowledge (B)

Process (A)

Observation (G), (D), (F)

Listening to questioning (A), (G), (F)

Delving into Bloom's (G)

Appendix F
Axial Codes for Emergent Themes from Interviews

Observation (F)

Student interview; process (F)

Evidence of Bloom's (G)

Think time (G)

All answers honored (G)

Multiple points of view (G), (F)

Logic in reasoning (G)

Details and elaboration (G)

Application to real world (F)

Synthesis for a practical purpose (F)

Compassion (F)

Higher Order Thinking (E)

Explain; apply to multiple situations (E)

Ask for proof (D)

Persuade (D)

Intellectual Criteria

Supportable facts (D), (E)

Supportable clear opinion (D)

Clarity in thought process (D)

Sequence (D)

Free-flowing and independent (D), (G), (F)

Logical reasoning (E), (A), (F)

Elaboration (A)

Appendix F
Axial Codes for Emergent Themes from Interviews

Contextual (A)

Desire to learn, not to please (A), (C), (B)

Make connections (C)

Analysis (G)

Perspective (F)

Empathy (F)

Compassion (F)

Appendix G
Sample Member Check

Hi Terry, Hope all is going well! How is the National Board work going? Remember, I'm keeping on top of it!

Attached please find the transcribed copy of our interview. Please read it and let me know if it looks o.k. to you. I can change anything you disagree with and will send you the final document when I finish.

Susan

Hi back! Looks good to me. I asked Mr. S. and he liked his too.

I'm not sure if I can finish the board entries in time. Turns out I'm getting married next year and that is taking a lot of time. I will let you know. Terry.