THE RELATIONSHIP BETWEEN CLASSROOM CHESS INSTRUCTION AND VERBAL, QUANTITATIVE, AND NONVERBAL REASONING ABILITITES OF ECONOMICALLY DISADVANTAGED STUDENTS

A Dissertation

By

JOSEPH W. EBERHARD

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CHAPTER I

INTRODUCTION

Research in the field of education has traditionally been difficult because researchers must deal with the unpredictability of human actions and values (Putnam & Borko, 2000). The policies and practices that drive education in America are founded on the interplay of three deeply held values: efficiency, equity, and excellence. These three values, as evaluated by Guthrie and Reed (1991) are inherently contradictory and the fulfillment of all three "virtually impossible." Historically, the Cold War has had a lasting impact on the interplay of excellence, equity, and efficiency, and concerns about technological gaps with the Soviets spurred an excellence in education movement. Concerns about poverty as the root of communism was a selling point for Johnson's War on Poverty (Dudziack, 2000). The Cold War had generated interest in educational excellence and economic inequities associated with racial inequity.

The third value, efficiency, was believed to be the best way to achieve both equity and excellence in education. Beginning in the 1980s with the 1989 Curriculum and Evaluation Standards to the more recent Goals 2000, proposals for standardized exams were promoted as an efficient way to achieve equity and excellence in education. The argument behind standardized exams was that they would raise the standards in education, especially in schools with large percentages of minority and economically disadvantaged students.

Standardization is a term of efficiency used in industrial production. In the industrial sector excellence is measured by profit, and financial efficiency is a means to achieve excellence. However, when industrial techniques of efficiency are applied to the

unpredictability of human behavior, the result is inequity. When a standard is applied in an industry, all companies must adjust to that one standard. Companies who already have that standard in place have an advantage over their competition. When standardization is applied to educational curriculum, one standard must be chosen on which to base the education of all children. Students whose learning style and social background were not in line with the educational standard chosen will be at a disadvantage compared to those students who were in line with the chosen standard. Research has determined that socio-economic status has more impact on academic achievement than ethnicity, indicating that the effects of standardization on cultural marginalization are best investigated in terms of socioeconomic culture.

Compounding the problem for economically disadvantaged students has been the high-stakes climate of the standardized exams. McNeil and Valenzuela argued that the accountability system of Texas was really a tool to efficiently manage administrators and teachers. The rating system sets up a winner and loser system with threats of government intervention for those schools who do not reach an acceptable level of passing rates. As a result, schools with predominantly economically disadvantaged students must reduce the curriculum to a focus on test preparation and offer test preparation classes as electives instead of other enrichment courses.

South Texas serves as a good place to study the effects of standardized exams on economically disadvantaged students. Texas leads the nation in the development of standardized curriculum and assessments, while South Texas is also one of the poorest regions in the United States (U.S. Census Bureau, 2001).

The problem for schools with high percentages of economically disadvantaged students is how to help students from an economically disadvantaged background to pass exams for which their cultural background has not prepared them. The concern for scholars who write about the unfairness of standardized exams is that the high-stakes nature of the exams forces low-income schools to narrow their curriculum at the expense of an enriched curriculum. The result is the creation of two very different educational systems: a narrowed, "teach to the test" curriculum for economically disadvantaged students and an enriched curriculum for middle and upper socio-economic students. The problem solving and higher level thinking that is developed through enrichment activities are still most accessible to upper socio-economic students (Cotlin, 1999).

As a result of the lack of enrichment, children from poverty eventually enter the school system behind other students in cognitive development (Leroy & Symes, 2001). This cognitive disadvantage often sets these students on a trajectory of low academic achievement with the social and self-esteem issues related to low achievement (Stipek & Ryan, 1997; Swanson & Alexander, 1997; Alivdrez & Weinstein, 1999).

In order to construct a better learning environment that supports the cognitive development of economically disadvantaged students, intervention programs should consider key characteristics of the culture of poverty. Prominent characteristics of the culture of poverty are: (a) children from poverty are entertainment oriented, rather than achievement oriented, (b) children from poverty tend to be more spatial in learning style than linguistic or mathematical, and (c) children from poverty must deal with what sociologists call compression (Payne, 1995, Fellin, 1995).

The entertainment-oriented learning style of economically disadvantaged students can be addressed through the concept of "learning through play." The theory of learning through play values the nature of play in the learning process of children and uses those values to advance educational needs (Franklin, 1998). The spatial learning style of economically disadvantaged students could be satisfied by teaching chess because researchers of cognitive development have identified the connection between spatial ability and problem solving in the game of chess (Gobet & Simon, 1992; Holly, 1997; Leamnson, 2000).

Psychologists have studied chess for over one hundred years in their search for an understanding of human thought processes and problem solving. In the last ten years alone psychologists have used chess players to study memory theories, contextual meaningfulness to memory, visual memory, motivation, the development of expertise, the relationship between knowledge and thinking, pattern identification, and problem solving. Many of these studies share a common conclusion: problem solving in chess depends on the application of past chess knowledge/experience to new chess problems and/or situations. In other words, using chess players, psychologists have learned that problem solving is an act of reflection on what is known and applying that knowledge to a new situation. Similar to the Constructivist Theory of learning, knowledge is constructed through the interaction of prior knowledge and current needs.

The proliferation of studies in which psychologists have identified chess play as a means to study cognitive processes and development may be of interest for educators to help economically disadvantaged students who are deficient in cognitive skills. While claims have been made about the social benefits of chess, very little rigorous research has

been published. In the area of chess and cognitive development in education, there have been several research studies conducted, but rarely matching a sound methodology with a statistically relevant sample size.

The late 1970s through the 1980s began a period of research investigating the relationship between chess and various educational interests. Studies investigated the relationship between chess and academic aptitudes (Frank, 1974), intellectual maturation (Christiaen, 1976), I.Q. improvements of Venezuelan school children (Gonzalez, 1989), critical and creative thinking skills (Ferguson, 1986), and verbal reasoning abilities (Ferguson, 1986). Many of these studies, however, lacked relevant samples in terms of numbers needed for statistical analysis and socioeconomic background.

With the standardization movement of the 1990s, chess and education research turned its attention toward the impact of chess on test scores. New Brunswick schools in Canada conducted one of the most methodologically sound studies while investigating improvements in the computational and problem solving portions of the test (Gqudreau, 1992). Margulies (1992) studied the impact of chess on the New York standardized reading exams. In Texas, a study of Texas Learning Index scores (TLI) over two years addressed improvements in math and reading on the Texas TAAS tests (Liptrap, 1998). These studies are often emphasized by supporters of chess in education as evidence of the value of chess in the high-stakes climate of standardization. However, these studies again fail to specifically address economically disadvantaged students, and they use a measurement format (standardized tests) that has not been documented as representative of learning. Nevertheless, these studies do reflect the recent preoccupation with standardized test scores. The earlier studies may have been more on track by

investigating aptitudes and cognitive skills, only to be derailed by the pressures to meet standardized expectations.

Whereas the 1970s and 1980s studies attempted to measure the cognitive underpinnings that many educators believed to be necessary for academic achievement, the 1990s studies attempted to evaluate academic achievement levels as a result of chess instruction. The 1980's studies assumed transference would take place, and the 1990s studies assumed that transference did take place. A doctoral dissertation by Rifner (1992) specifically investigated the issue of transference of chess skills to an academic subject. Rifner conducted a study to determine if problem-solving skills learned from chess instruction transferred to poetic analysis, concluding that transfer could be achieved if transfer was an instructional goal.

For chess to be used as the entertaining, spatial heuristic for economically disadvantaged students to develop problem solving skills that will transfer to other academic subjects, teaching chess with the objective of transfer would be needed. Chess instruction could be conducted in various ways, including after school programs, reward in the regular classroom setting, or even a chess class offered as an elective. When designing a chess program to promote cognitive development for economically disadvantaged students, consideration must be made for the issue of compression found in the culture of poverty. To counter compression, economically disadvantaged students need a learning envrionment where a culture of achievement is nurtured through mutual support. A chess class offers the supportive social structure for challenging the "self-as-learner" (Lin, 2001).

Problem Statement

Arguments have been developing for and against the use of standardized high-stakes testing and the effects it may be having on the quality of learning. While arguments have been made that standardized testing has actually created a system in which minority and economically disadvantaged students are ensured a more equitable education, contradictory opinions claim that standardized high-stakes exams have created two different systems of education: an enriched curriculum for mainstream middle and upper class students whose environmental experiences and cognitive styles are already aligned with the standardized curriculum, and the streamlined curriculum for economically disadvantaged students who often enter the school system with cognitive deficiencies (McNeil, 1998; Hurwitz, 2000). Proponents of standardized testing argue that it is an efficient means to achieve equity. Opponents of the testing system argue that while it may provide efficiency, on paper, in basic outcomes it does not express the cost to long-term cognitive development. The pressure on low-income districts to comply with standards has required a restructuring of necessity of the educative process in many schools. This includes the reduction, if not elimination, of many enrichment activities (Gratz, 2000).

Educators in low income districts find themselves looking for ways to provide the enriched experiences that develop the thinking skills economically disadvantaged students need to succeed in school (Gratz, 2000), but often lack when entering the school system (McNeil, 1998). Problem solving has long been identified as an essential cognitive skill that predicts academic skills such as reading and math (Harcourt Brace, 1997; Thorndike & Hagan, 1986). The best way to teach problem solving has been

through hands-on, problem centered experiences that "provide opportunities for students to acquire in-depth knowledge and develop critical and creative thinking skills, problem finding, and problem solving" (Dooley, 1997, p. 192). Unfortunately, the curriculum designed to train students to pass the standardized tests is not based in problem solving.

A problem facing low income school districts is how to comply with the high-stakes testing standards mandated by the legislatures, while at the same time providing an enriched curriculum that develops the problem-solving skills economically disadvantaged students will need for academic achievement. This is the dilemma for campuses and districts with a dominant economically disadvantaged student population.

Purpose of the Study

The spatial and visual nature of chess, its entertaining game approach to thinking, and the growing support to include it as part of co-curricular/extracurricular activities, are all consistent with the needs of economically disadvantaged students. The purpose of this study was to investigate the impact of chess instruction on the nonverbal reasoning ability of middle school students identified as economically disadvantaged. Students at a South Texas, Region 2, middle school participated in this study. The campus has an ethnic breakdown and percentage of economically disadvantaged students that is similar to the overall demographics of South Texas. Schools with predominantly low-income populations might be able to solve the standardization dilemma with the inclusion of chess instruction as a heuristic enabler for improving the problem-solving skills of children from poverty. Information obtained from the study might be used to develop enrichment programs (such as chess) for teaching problem-solving skills to economically disadvantaged students.

Research Questions

Based on the problem statement and purpose of this study, the following research questions were devised for this study:

1. Is there a significant difference in verbal, quantitative, and nonverbal reasoning abilities, as measured with pre-tests and post-tests, for all students who received formal classroom chess instruction?
2. Is there a significant difference in verbal, quantitative, and nonverbal reasoning abilities, as measured with pre-tests and post-tests, for all students who did not receive formal classroom chess instruction?
3. Is there a significant difference in verbal, quantitative, and nonverbal reasoning abilities, as measured with pre-tests and post-tests, for economically disadvantaged students who received formal classroom chess instruction?
4. Is there a significant difference in verbal, quantitative, and nonverbal reasoning abilities, as measured with pre-tests and post-tests, for economically disadvantaged students who did not receive formal classroom chess instruction?
5. Is there a significant difference in verbal, quantitative, and nonverbal reasoning abilities, as measured with pre-tests and post-tests, for students not identified as economically disadvantaged who received formal classroom chess instruction?
6. Is there a significant difference in verbal, quantitative, and nonverbal reasoning abilities, as measured with pre-tests and post-tests, for students not

identified as economically disadvantaged who did not receive formal classroom chess instruction?

7. Is there a significant difference between the pretest-posttest change of performance levels on the verbal reasoning abilities test for students identified as economically disadvantaged and students not identified as economically disadvantaged who received formal classroom chess instruction and students who did not receive chess instruction?
8. Is there a significant difference between the pretest-posttest change of performance levels on the quantitative reasoning abilities test for students identified as economically disadvantaged and students not identified as economically disadvantaged who received formal classroom chess instruction and students who did not receive chess instruction?
9. Is there a significant difference between the pretest-posttest change of performance levels on the quantitative reasoning abilities test for students identified as economically disadvantaged and students not identified as economically disadvantaged who received formal classroom chess instruction and students who did not receive chess instruction?

Research Hypotheses

The following hypotheses, based on the research questions, were formulated for the study:

1. There is a significant difference in verbal reasoning abilities, as measured with pre-tests and post-tests, for all students who received formal classroom chess instruction.

2. There is a significant difference in quantitative reasoning abilities, as measured with pre-tests and post-tests, for all students who received formal classroom chess instruction.
3. There is a significant difference in nonverbal reasoning abilities, as measured with pre-tests and post-tests, for all students who received formal classroom chess instruction.
4. There is a significant difference in verbal reasoning abilities, as measured with pre-tests and post-tests, for all students who did not receive formal classroom chess instruction.
5. There is a significant difference in quantitative reasoning abilities, as measured with pre-tests and post-tests, for all students who did not receive formal classroom chess instruction.
6. There is a significant difference in nonverbal reasoning abilities, as measured with pre-tests and post-tests, for all students who did not receive formal classroom chess instruction.
7. There is a significant difference in verbal reasoning abilities, as measured with pre-tests and post-tests, for economically disadvantaged students who received formal classroom chess instruction.
8. There is a significant difference in quantitative reasoning abilities, as measured with pre-tests and post-tests, for economically disadvantaged students who receive formal classroom chess instruction.

9. There is a significant difference in nonverbal reasoning abilities, as measured with pre-tests and post-tests, for economically disadvantaged students who received formal classroom chess instruction.
10. There is a significant difference in verbal reasoning abilities, as measured with pre-tests and post-tests, for economically disadvantaged students who did not receive formal classroom chess instruction.
11. There is a significant difference in quantitative reasoning abilities, as measured with pre-tests and post-tests, for economically disadvantaged students who did not receive formal classroom chess instruction.
12. There is a significant difference in nonverbal reasoning abilities, as measured with pre-tests and post-tests, for economically disadvantaged students who did not receive formal classroom chess instruction.
13. There is a significant difference in verbal reasoning abilities, as measured with pre-tests and post-tests, for students not identified as economically disadvantaged who received formal classroom chess instruction.
14. There is a significant difference in quantitative reasoning abilities, as measured with pre-tests and post-tests, for students not identified as economically disadvantaged who received formal classroom chess instruction.
15. There is a significant difference in nonverbal reasoning abilities, as measured with pre-tests and post-tests, for students not identified as economically disadvantaged who received formal classroom chess instruction.

16. There is a significant difference in verbal reasoning abilities, as measured with pre-tests and post-tests, for students not identified as economically disadvantaged who did not receive formal classroom chess instruction.
17. There is a significant difference in quantitative reasoning abilities, as measured with pre-tests and post-tests, for students not identified as economically disadvantaged who did not receive formal classroom chess instruction.
18. There is a significant difference in nonverbal reasoning abilities, as measured with pre-tests and post-tests, for students not identified as economically disadvantaged who did not receive formal classroom chess instruction.
19. There is a significant difference between the pretest-posttest change of performance levels on verbal reasoning abilities of all students identified as economically disadvantaged and all students not identified as economically disadvantaged.
20. There is a significant difference between the pretest-posttest change of performance levels on verbal reasoning abilities of students who received formal classroom chess instruction and students who did not receive chess instruction.
21. There is a significant interaction between subject effects of chess instruction versus no chess instruction and students identified as economically disadvantaged versus students not identified as economically disadvantaged on the pretest-posttest change of performance levels on verbal reasoning abilities.

22. There is a significant difference between the pretest-posttest change of performance levels on quantitative reasoning abilities of all students identified as economically disadvantaged and all students not identified as economically disadvantaged.
23. There is a significant difference between the pretest-posttest change of performance levels on quantitative reasoning abilities of students who received formal classroom chess instruction and students who did not receive chess instruction.
24. There is a significant interaction between subject effects of chess instruction versus no chess instruction and students identified as economically disadvantaged versus students not identified as economically disadvantaged on the pretest-posttest change of performance levels on quantitative reasoning abilities.
25. There is a significant difference between the pretest-posttest change of performance levels on nonverbal reasoning abilities of all students identified as economically disadvantaged and all students not identified as economically disadvantaged.
26. There is a significant difference between the pretest-posttest change of performance levels on nonverbal reasoning abilities of students who received formal classroom chess instruction and students who did not receive chess instruction.
27. There is a significant interaction between subject effects of chess instruction versus no chess instruction and students identified as economically

disadvantaged versus students not identified as economically disadvantaged on the pretest-posttest change of performance levels on nonverbal reasoning abilities.

Importance of the Study

This study can contribute important information regarding the pedagogical needs of economically disadvantaged students. The narrowing curriculum for economically disadvantaged students as a means to increase passing rates is creating two different qualities of education (McNeil, 1998). The first type of education is for students in middle and upper class schools who enter school with the culturally relevant social and cognitive skills that schools are based on. This first type of education includes many enrichment activities and environments, resulting in cognitive development that is relevant to the early years of education. The second type of education is students from economically disadvantaged backgrounds where the thinking skills and reasoning strategies reflect the culture of poverty. When students from the second group enter the middle class culture of the schools, and the standardized assessment component, they are often "taught to the test" at the expense of enrichment activities. A lack of enrichment activities reduces the development of higher order thinking skills that lead to long term learning skills.

This study might demonstrate the effectiveness of formal classroom chess instruction on the development of nonverbal problem-solving skills for economically disadvantaged students for scholastic achievement. As a result, educators in South Texas might be able to offer chess as an enriched activity that teaches problem-solving skills while at the same time preparing students to perform better on standardized tests, rather

than having to teach to the test in response to high-stakes demands. Chess instruction could contribute to achieving the equity versus efficiency dilemma in low-income school districts.

Although formal classroom chess instruction is being offered in several low-income districts, no studies exist to investigate the impact of chess instruction on the nonverbal problem-solving abilities of economically disadvantaged students. This study is important because it can provide needed research in the field of chess in education and the educational needs of economically disadvantaged students.

Definition of Terms

1. Academic achievement – Often measured in terms of results from the Texas Assessment of Academic Skills, but in this study will also be used when discussing whether TAAS is an appropriate means of measuring achievement for economically disadvantaged students.
2. Brain-based learning – Developments in computer technology have provided new understandings and theories of the physiological workings of the human brain, and how they relate to learning. Brain-based theories are still in the early stages of development and do not have the research to support wide spread applications to the classroom.
3. Compression – In families from poverty, children are considered valuable "possessions." When a child from poverty begins to learn the hidden rules of the middle class school culture, family members will appear to be attempting to interfere with the child's successes. Actually, the family is concerned about the child leaving. Compression is a phenomenon of low income culture where various

strategies are applied to keep an individual from advancing socially or economically.

4. Culture – A way of seeing, perceiving, believing, and understanding the world.
5. Culture of Poverty – A self-perpetuating complex of escapism, impulse gratification, despair, and resignation.
6. Declarative knowledge – Factual knowledge that can be easily learned and just as easily forgotten.
7. Economically disadvantaged – The term used to identify students in the school system that qualify for free or reduced lunch. Free lunch would be for those students that are statistically living in poverty and reduced lunch is for those students that are near the poverty level. Economically disadvantaged is an identifying characteristic of children at-risk of dropping out of school.
8. Effective teaching – Teacher techniques and attitudes that optimize student results.
9. Enrichment activities – Activities and knowledge that are relevant to the learner's contextual environment.
10. Generalize – A process having the ability to be more widely applicable.
11. Habit of mind – A process that has been internalized and can be utilized with very little conscious effort.
12. Hidden rules – The unspoken customs, modes of behavior, and expectations of human relationships.
13. Intelligence – This term has many definitions but most imply the ability to adapt with some form of decision making within the context of a changing environment.

14. Learning Through Play – Teaching social skills, thinking skills, and academic aptitudes through games.
15. Nonverbal reasoning – Logical analysis using geometric shapes and outlines.
16. Pattern identification – The ability to use comparison, contrast, sequencing, cause and effect, and other higher order thinking skills to recognize relationships and integrate knowledge.
17. Pedagogical skills – Cognitive and affective skills of a teacher in dealing with children.
18. Play therapy – A methodology of therapy used by psychologists where games are used to teach thinking skills.
19. Problem solving – The ability to consider numerous variables, including predictions of future obstacles, to obtain an outcome that is favorable to the person with a problem.
20. Procedural knowledge – Knowledge that is not contextual because it does not need a perceived objective event to be remembered. Procedural knowledge is difficult to learn but also very difficult to forget.
21. Quantitative reasoning – Logical analysis using mathematical principles.
22. School culture – From a systems perspective, school culture is the standardized way of seeing, perceiving, believing, and understanding the world as influenced by elements within the local community, leadership styles of administrators, national and state ideologies, expectations of students and staff, etc.
23. Self-esteem – How someone feels about themselves in relation to the standardized culture of the dominant ideology.

24. Serial reasoning – Using logical analysis to recognize a sequence of geometric shapes.
25. Standardization – In Liberal ideology, it is the process of developing a middle, or centrist, position. Standardized curriculum and assessments also create a centrist position of what is expected. Standardization, therefore, becomes a tool of dominant cultures to promote efficiency at the expense of equity.
26. Transference – When previously learned knowledge or skills influences current learning or problem solving, transference has occurred.
27. Verbal reasoning – Logical analysis using linguistic principles.

Limitations of the Study

The following factors may have limited the validity or generalizability of the findings of this study:

1. Some families do not want their children identified as economically disadvantaged and did not complete the paperwork for free/reduced lunch. Therefore, there is a possibility that the results of some of the students will not reflect their actual economic standing. Students that are in reality living in poverty but are not identified by the campus may have had their results computed in the 'not economically disadvantaged category'. Depending on the level of change in performance from the pre-tests to the post-tests, the results for these students may have slightly altered p-values toward acceptance or rejection of select null hypotheses. It was not possible to control for how many of the participants in the study were economically disadvantaged

qualified students who did not file for free/reduced lunch at the beginning of the school year.

2. Effective teaching of any subject is easier to achieve when various pedagogical skills are combined with strong content knowledge. In this study it was not within the control of the researcher to select instructors for the chess classes that had both pedagogical skills and high levels of chess knowledge. The individual student's relationship with the chess teacher could have influenced his or her efforts on the tests and/or on the daily lessons and activities. The teacher as role model for problem-solving skills was important to this study, but it was not possible to test for the difference in effectiveness of teachers on student improvements in post-test scores. Such a test would require a control group in which a teacher with pedagogical skills and content knowledge was intentionally denied to the students. Intentionally denying students' effective teaching would be unethical, and, therefore, the role of the teacher's pedagogical skills and content knowledge were accepted as being beyond the scope of this study.

3. Student awareness of the existence of an ongoing study may have influenced individual efforts on either/both the pre-tests and post-tests, and/or on the daily lessons and activities. Teachers were informed and reminded periodically of the importance of not emphasizing the research aspect of the chess class. Although all teachers assured the researcher that students were not told about the collection of data, it was not possible to completely secure such discretion.

4. All students took the same tests for both the pre-tests and the post-tests. Test familiarity may have effected student answer selections during the post-test.
5. The sample population for the study was self-selected, non random because students were assigned to the chess class electives based on scheduling concerns, class size limits for other electives, and counselor discretion. Disadvantaged students will be in both the experimental and control groups.
6. Participant mortality was affected by high levels of student transfers in and out of classes, and in and out of the school. Therefore, some batteries tested had more sets of scores than other batteries.
7. Because the classes were self-selected, the number of students enrolled in the chess classes identified as either economically disadvantaged or not economically disadvantaged could not be controlled. Although the number of economically disadvantaged students enrolled in both the experimental and control groups was large enough to run a statistical analysis, the number of students not identified as economically disadvantaged in the experimental group was smaller than the 30 participants needed for statistical relevance to be determined.

CHAPTER II

REVIEW OF THE LITERATURE

Introduction

This review of literature was divided into three major sections with subsections. The first section deals with the problem of offering an enriched curriculum for the development of problem solving skills in schools with high percentages of economically disadvantaged students. This problem is developed within the context of high-stakes standardized exams. The argument was developed around the contradictory values of efficiency and equity that have been rhetorically promoted under the value of excellence.

The second major section argues that Constructivist Learning Theory offers an educational approach to address both the cognitive and social needs of students, especially those economically disadvantaged students who enter school deficient in problem solving skills. This section investigates the social nature of intelligence, how environment influences cognitive development, how cognitive skill level, in turn, influences social perceptions, and how to build a learning environment from the values inherent in the culture of poverty.

The last major section reviews the literature on chess as a tool for investigating cognitive development and the attempts to discover whether or not chess could develop problem solving in students. Chess as a tool for psychologists, chess instruction as a tool for education, and consistencies with constructivist methodologies are reviewed.

The Dilemma for Schools with High Percentages of Economically Disadvantaged Students

Equity and Efficiency

Scholars who conduct research in the field of education have had to deal with accusations that they are conducting soft research, as compared to the hard sciences (Putnam & Borko, 2000). The hard sciences are perceived as more rigorous because they deal with knowledge that experts in their fields agree upon. Researchers of education, however, deal "with the inherent unpredictability of human action and values" (Putnam & Borko, 2000, p. 12). It is the unpredictability of values that cause trends in educational theory, even cycles of ideas. Because education is a field of study embedded in the "unpredictability of human action and values," and under the direction of public policy, the actions and values of a society can contradict each other, creating difficult dilemmas for educators.

Guthrie & Reed (1991) argued that "U.S. school policies and practices are the result of a constant interplay between proponents of three deeply held values – equality, efficiency, and liberty" (p. 26). Guthrie & Reed (1991) provide a detailed analysis arguing that "despite widespread public devotion to these values as abstract goals, their ultimate fulfillment is virtually impossible... at their roots, the three desired conditions are inconsistent and antithetical" (p. 26). The purpose of this section of the review of literature was to investigate the impact of the interplay of these values on education.

Since the early days of industrialization in America, efficiency has been a value for improving the most important result for a business, profit. Efficiency in the use of natural resources and capital, as well as standardization of production, creates financial

savings and increased profits. Efficiency had become an American value because of industrialization. During the Cold War equity and excellence joined efficiency in the triumvirate of American values.

Historically, the Cold War has had a lasting impact on the interplay between the values of equity, efficiency, and excellence. When the Soviets launched the satellite Sputnik in 1957, American politicians fearfully responded with accusations that American school children needed to be better prepared in math and science to keep up technologically with the Soviet Union. As a result, Congress passed the National Defense Education Act of 1958, making education one of the weapons for fighting the Cold War. Education had been brought into the political realm of national defense, and excellence in education was seen as critical to winning the Cold War. From an historical perspective, the Civil Rights movement and Lyndon Johnson's War on Poverty achieved political support at the national level because of their Cold War implications (Dudziack, 2000). Efficiency, equity, and excellence had made their way into the value structure of American education.

Toward Equity

The last 50 years have been a period of increased national awareness about the impact of poverty on the overall well being of national, state, and local communities. The increased awareness can be explained in political terms as a Progressive social reform supported by a government that needed to improve national self-image in the midst of Cold War competition. Asian and African nations emerged from colonial rule and the United States and the Soviet Union served as models for the new nations. Emerging nations where poverty was rampant were most likely to consider a political system that

best dealt with the issue of poverty (Dudziak, 2000). The 1960's, therefore, ushered in two decades of concern about equity (racial and economic). Only recently have scholars clarified the connection between race and socio-economic status. Due to high poverty rates among minorities, socio-economic status is now considered to be more of a determinant of student success than racial/ethnic background (Desimone, 1999; Hickman, 1995). Therefore, while this review of literature addresses minority issues when appropriate, the focus of the equity value will be socio-economic.

In 1965, President Johnson's War on Poverty established poverty as a Cold War threat to national security. Along with governmental support for a Civil Rights Movement that would demonstrate to emerging African nations that democracy, not communism, was the best political system, the War on Poverty was an integral part of a decade focused on equality (Dudziak, 2000). The 1965 Title I and/or Chapter I of the Elementary and Secondary Education Act (ESEA) first provided federal funds and was the starting point for many later federal programs. These programs included Head Start, Homeward Bound, Job Corps, Neighborhood Youth Corps, Manpower Development and Training, the Teacher Corps, and the School Lunch and School Breakfast program (Flaxman, Burnett, & Asher, 1995).

Poverty was defined in 1963 by Mollie Orshansky, a social science research analyst for the Social Security Administration, as an income that was below the minimal dietary needs according to the Economy Food Plan of the U.S. Department of Agriculture. The educational system categorized students below the poverty line for free-lunch and near the poverty line for reduced prices (Fisher, 1992; Gould, 1972). Recent calculations placed the poverty threshold at $17,028 for a family of four.

The documentation that qualified students for free or reduced lunch provided a tool for tracking the academic success of economically disadvantaged students. Given (1998) argued that because of a lower quality diet, children from poverty experienced chemical imbalances that affect mood and motivation. Lack of proper diet for humans will make dopamine transform into norepinephrine, meaning alertness is replaced by aggression and agitation. When nutrition is poor, children have difficulty tolerating frustration and stress; they become apathetic and are non-responsive, inactive and irritable (Given, 1998). This can make students appear to be unmotivated. The government believed that addressing the nutritional aspect of poverty (nutritional equity) would influence equity in academic achievement (Dudziak, 2000). Even today, the relationship between access to nutrition and the academic performance of economically disadvantaged students has the attention of educators and policy makers nationwide. Educational Leadership ran a special issue investigating the relationship between nutrition and academic performance (Wolfe, Burkman, & Streng, 2000). The identification of economically disadvantaged children through the free/reduced lunch program created a paper trail of documentation that allows for the tracking of the achievement levels of economically disadvantaged students. The desire for nutritional equity set the stage to track specific quantifiable measures of academic equity. Even today, economically disadvantaged is an important subgroup of the Texas standardized testing accountability rating system.

Health care for economically disadvantaged students has a recent development that parallels the concerns that prompted the free lunch program of the 1960's. For families without Medicaid or personal insurance, a major health crisis in the family can

consume nearly all expendable income, and can be the cause of a student dropping out of school to get a job (Tinsley, 1999). The Children's Health Insurance Program (CHIP) is a federal program designed for Texas children who do not receive Medicaid, but whose parents cannot afford private health insurance (Tinsley, 1999; CHIP, 2001). According to the Center for Public Policy Priorities, the proportion of children in Texas working-poor-families who had no health insurance is one-third higher than the average for other states. More than one in three Texas children from working-poor-families lacked health insurance, and two-thirds of the parents had no insurance of any kind. According to Tinsley (1999), about 400,000 of Texas' estimated 1.4 million uninsured children can be covered by CHIP.

Both the school-lunch program that began in the 1960's and the health insurance programs of the 1990's have targeted social problems of the impoverished environment that were believed to be affecting student success. Interestingly, both movements borrowed the industrial value of efficiency in the belief that money spent early in the child's life would save money in the long run and result in a more educated "product". Both movements sought to solve apparent inequities in academic achievements through economic efficiency.

Toward Efficiency

When the Cold War heated up in the 1980s, education was again under attack by government officials. As the Reagan administration struggled to push forward high tech programs, studies comparing results on standardized math and science scores between children from the industrialized nations of the world indicated that American children were far behind their European and Asian counterparts. The results were part of an

inquiry by the National Commission on Excellence in Education, resulting in the publication of A Nation at Risk in 1983 (U.S. Department of Education, 1983). Current research on the findings of this publication indicate that the comparisons were made on several faulty assumptions, such as which student scores from the various countries were included in the tabulations, and who was eligible to take the tests (Masini & Edirisooriya, 2000). Nevertheless, A Nation at Risk has inspired reform initiatives that have had long term effects on public education (Berliner & Biddle, 1995).

Much like the 1950's Sputnik scare, A Nation at Risk put public education under the microscope of politicians and rhetorically within the realm of national security. Education as an industry was considered economically inefficient (U.S. Department of Education, 1983). What followed was a train of proposals for academic excellence: 1989 Curriculum and Evaluation Standards for Mathematics, 1991 National Education Goals Report, 1995 National Standards in American Education, 1998 National Assessments of Education Progress, and Goals 2000. According to these proposed responses to A Nation at Risk, the best way to solve the reported problems was to develop curriculum standards and to assess the success rates of teaching those standards. Some states, like Texas, created accountability systems for campuses and districts based on the results of those standardized exams. According to McNeil and Valenzuela (1998), the Texas system of standardization was a "management system" designed to "change the behavior of teachers, through increased accountability" (p. 1). The value of efficiency was being promoted as a means to achieve academic excellence.

Standardization has been promoted, rhetorically, as an excellence in education movement since the early 1980s. More specifically, standardization was supposed to be

an excellence in education movement that targeted minorities in poor school districts. The social issues of poverty and the concerns about academic deficiencies in comparison to other nations fused under the banner of excellence in education. Through government efficiency, educational standards were supposed to make American students more competitive internationally, and ensure a quality education for minorities and economically disadvantaged students. The proposition that minorities in poor districts were supposed to benefit the most from standardization lacked research to support these claims (McNeil & Valenzuela, 1998). The antithetical problem lies in the fact that the government chose the value of efficiency to attempt excellence, and imply equity. A closer examination of these antithetical values will show that instead of creating equity, standardization may have actually widened the gap between economically disadvantaged students and middle/upper socio-economic students. Texas provides an excellent example because of its leading role in the standardization movement and its possession of the most economically depressed regions in the nation (South Texas).

Toward Equity in Texas

In Texas, 24% of children under the age of eighteen live in poverty, and 26% of children under the age of five live in poverty (U.S. Census Bureau, 2001). That means that nearly 1 in 4 children of school age lives in poverty and 1 in 4 children in their critical pre-school developmental stages also live in poverty. According to the U.S. Census Bureau's (2001) "Small Area Income and Poverty Estimates Counties That Could Be Identified As The Poorest County in the U.S. in 1997", Texas had 19 of the poorest counties in the top 77 listed for the entire United States. Of the Texas counties on the list, 16 of them are in South Texas (see Appendix A for listing). These counties represent

poverty rates that range from 30% to 45% for all ages combined. The only other state with multiple counties ranked in the top ten is South Dakota with three counties (due to traditionally impoverished Native American reservations). Based on this data, South Texas is one of the most impoverished regions in the United States.

When calculating percentages of economically disadvantaged students enrolled in Texas schools, and especially in the high poverty region of South Texas, the Standard Reports Division of the Texas Education Agency (2001) provided data for all schools, districts, regions, and the state. The number of students who qualified for free or reduced lunch in Texas was 49%, one-half of all students enrolled. In South Texas (defined as Regions 1, 2, 3, and 20) 69% of enrolled students qualified for free or reduced lunch, 20% higher than the state average. That means seven in ten children in South Texas have been identified as economically disadvantaged.

Texas has not been immune to the issues of equity and efficiency in education. In the 1990s Texas became an innovator and national role model for new programs to deal with poverty and for promoting efficiency through standardized education. An attempt to become more financially efficient was the landmark court case *Edgewood vs. San Antonio,* 1989. Texas attempted to deal with discrepancies between wealthy and poor school districts through a redistribution of district tax dollars (Newman, 1990). According to Guthrie & Reed (1991), however, finance is an issue of efficiency. Texas has used economic efficiency in an attempt to address equity.

Toward High-Stakes Testing Efficiency in Texas

Just as the values of equity and efficiency have overlapped, the values of efficiency and excellence have been interchanged to the point that excellence in

education has been attempted through efficiency in curriculum and testing. Texas is leading the way in the development of standardized curriculum, standardized assessments, and accountability for educators as part of an excellence in education movement. Texas has used standardized testing since the 1980s, but in the 1990s Texas reformed its own system creating the Texas Assessment of Academic Skills (TAAS) in 1994 and the Texas Essential Knowledge and Skills (TEKS) curriculum in 1998. Currently, Texas is revamping the evaluation component of the standardization system with the implementation of the Texas Assessment of Knowledge and Skills (TAKS). Curriculum alignment has been considered by most schools as necessary to succeed on the standardized exams, the objectives of which now come entirely from the TEKS (Ediger, 2000).

Texas has also implemented an accountability system that recognizes successful schools and penalizes unsuccessful schools. State legislators have, in effect, implemented a rewards and punishment accountability system. The result has been a "high stakes" climate with administrative and teacher job stability being heavily related to the passing percentages of their students on the standardized exams (Hurwitz, 2000).

Efficiency Contradicts Equity

When TAAS was originally created a major argument in support of the reforms was that it would force school districts to pay attention to the educational needs of all children, specifically minority and economically disadvantaged students (Hurwitz, 2000). While the "rhetoric surrounding this accountability system is that it is raising educational quality," or excellence, the use of standardized curriculum and assessments is a tactic of efficiency (McNeil & Valenzuela, 1998, p. 1). Standardization, after all, is an industrial

term for a unified system of measurement with the intent of increasing efficiency (Gutek, 1997).

A good example of how standardization within an industry creates inequity is the standardization of the distance between track rails in the late 1880's. At the time, the width between the rails was different in each state, making interstate shipping inefficient. When the government standardized the width between the rails, one width was chosen and all other railroad companies were required to change to the one standard. Those companies with the width already in place were at an advantage for several years because it was "business as usual". For the companies without the correct width between rails, it required money, effort, and time to adjust to the standard. Companies that could not afford the transition, or could not do so quick enough to keep pace with other companies, would often go bankrupt. In effect, many companies were pushed to the margins of the railroad industry, setting the stage for the era of railroad conglomerates. Standardization of rails created an inequity between companies based on what standard was chosen (Kolko, 1965).

Although standardized curriculum and evaluation has been promoted as an issue of equity based on excellence for all, academic standardization as a tool of efficiency may be creating inequity. Standardized curriculum and exams select what is important, requiring all students to conform to that standard, regardless of socio-economic background, resources, or learning styles (McNeil & Valenzuela, 1998). Proponents of multicultural education have argued that such standardization leads to the marginalization of minority populations and their cultures (Harris, 1995). McNeil & Valenzuela (1997) argued that the standards chosen were those of white, middle and upper class society.

This argument is only relevant, of course, if research demonstrates that economically disadvantaged children do have different learning styles and resources from the standard chosen. This issue will be addressed later in this review of literature.

In Texas, the fastest-growing segment of the public school population has been economically disadvantaged students, accounting for half of those enrolled (T.E.A., 2001). Based on an increasing Hispanic population, Texas is on the verge of becoming a "minority-majority" state. Coupled with the fact that the poverty rates of Hispanics remain the highest for any racial group, a growing percentage of children are marginalized by standardized curriculum and assessments (O'Connell, 1998). In South Texas, the impact is even greater. Nearly 70% of the students in South Texas could be considered marginalized by standardization because of their cultural differences based on low socio-economic status alone. Marginalization, as a result of standardization, is what Guthrie & Reed (1991) referred to as the "inconsistent and antithetical" nature of equality and efficiency.

Efficiency versus Equity: From TAAS to End-of-Course Exams

An analysis of differential TAAS scores since 1994 between White students and African American, Hispanic, and economically disadvantaged students reveals a closing gap over the last five years (T.E.A., 2001). Such results suggest the renewed emphasis on excellence in education has resulted in improved academic equity for minorities. However, double-digit gaps still existed between African American students and White students, Hispanic students and White students, and economically disadvantaged students and White students in reading, writing, and math scores (See Appendix B). Despite the double-digit gaps between White students' scores and the predominantly economically

disadvantaged minority students' scores, the general improvement in scores suggested that equity had been achieved through an emphasis on excellence using an efficient measurement system. However, when a similar review of the End-of-Course exams at the high school level compared the same ethnic and socio-economic groups, the gaps were as large as the original TAAS gaps from eight years earlier (See Appendix C). Whatever the reasons for the improvements for economically disadvantaged students on the TAAS scores may have been, the effect was apparently short term. The large gaps in End-of-Course scores suggest that economically disadvantaged students did not develop long term academic skills in the process of their TAAS improvements. Because of the accountability system related to TAAS and TAKS, preparation has become a multi-billion dollar industry, transforming the educational objectives of many low-income campuses. Accountability has not yet been attached to the End-of-Course exams, and test prep classes and standardized curriculum have not yet been implemented.

The implication of the TAAS to End-of-Course comparison is how education is defined. Supporters of standardized TAAS scores might argue that an excellent education can be determined through a single measurement (Brooks & Brooks, 1999). The gap for economically disadvantaged students on End-of-Course exams, however, revealed that skills do not seem to have been retained as economically disadvantaged students moved into high school. An alternative definition of education (that requires the teaching of social and thinking skills) that can be used in future settings would argue that the TAAS scores do not represent learning (Brooks & Brooks, 1999). The End-of-Course exam scores indicated that minorities and economically disadvantaged students

did not learn long term academic skills. Ironically, these were the same students standardization was supposed to help.

The Impact of Efficiency on Learning: Two Systems of Education

Linda McNeil and Angela Valenzuela's research (1998) on the impact of the TAAS system in Texas provided both quantitative and qualitative data for an argument on the harmful effects of academic standardizatization on children from poverty. The authors addressed the dilemma of schools with high percentages of economically disadvantaged students. The basis of their argument was that the socio-economic background, resources, and learning styles differences of economically disadvantaged students marginalized them and subjected them to strategies that responded to the need to meet the standards, not the need to educate the child based on his/her needs. The authors used "a longitudinal analysis of instruction when test-prep materials become the curriculum", a "multi-year study of Latino children's high school experiences, investigations of Latino elementary schools, and research in urban schools" (McNeil & Venezuela, 1998, p. 2).

McNeil and Valenzuela argued that "schools that have historically been under-resourced" were under the most pressure to raise test scores, and that "behind the rhetoric of rising test scores are a growing set of classroom practices in which test-prep activities are usurping a substantive curriculum," (1998, p. 2). These schools have replaced regular education with activities whose sole purpose is to raise test scores (Gratz, 2000; McNeil & Valenzuela, 1998). This is similar to the implications within the comparison of TAAS scores to End-of-Course scores (in Appendices B and C): "by keeping children focused on these drills and these disembodied facts, the TAAS system of testing is

denying them access to forms of knowledge and ways of knowing that can lead them beyond this minimal level, into higher forms of learning" such as "improved capacities for complex problem solving" (McNeil & Valenzuela, 1998, p. 9; also discussed in Sylwester, 1995).

McNeil and Valenzuela (1998) expressed concern that "TAAS drills are becoming the curriculum in our poorest schools," while middle class schools "are reading literature, learning a variety of forms of writing, and studying mathematics aimed at problem-solving and conceptual understanding" (p. 4). Since teaching to the test is successful in raising standardized test scores, programs such as TAAS may be falsely given credit for raising the excellence standard. However, as McNeil and Valenzuela (1998) reported, TAAS scores "mask the inequities produced when schools raise test scores at the expense of substantive learning" (p. 3). In essence, two curriculums, two pedagogies, have developed: one for economically disadvantaged students and the other for middle/upper socio-economic students.

The schools with high percentages of economically disadvantaged students must respond to the high-stakes tests by an efficient streamlined test preparation curriculum instead of an enriched curriculum that develops problem solving skills (Hurwitz, 2000). The creation of special programs geared toward economically disadvantaged students' passing high-stakes standardized exams, in effect, has created an economic tracking system within schools and districts (Hurwitz, 2000). Johnson (1997) argues that this tracking system is a roll back of Brown vs. Board of Education's separate but equal rulings, especially when there are districts with very high rates of economically disadvantaged students. In other words, standardized exams may be in the process of

creating two different qualities of education based on socio-economic status. Despite efforts of efficiency to alleviate the nutritional and medical insurance deficiencies of an impoverished environment, efficiency through standardized education has not alleviated the cognitive deficiencies that children from poverty take to school (Payne, 1995)

If streamlined curriculum reduces the enrichment needed to develop cognitive processes, then providing enrichment opportunities for cognitive development would be an important step in educating children from poverty. The National School-Age Care Alliance Quality Standards specified that children should have a chance to join enrichment activities that can promote higher-level thinking (Roman, 1998). Enrichment programs can be divided into two broad categories: extracurricular and academic enrichment (Coltin, 1999). Coltin wrote that affluent suburban children have traditionally been exposed to enrichment activities, but the U.S. Department of Education and U.S. Department of Justice emphasized the need for such activities for all children (Coltin, 1999; U.S. Department of Education, 1998). Examples of enrichment activities include photography, hands-on math and science projects, and chess (Cotlin, 1999; Roman, 1998). Cotlin (1999) argued that despite the awareness that all children need enrichment, enrichment programs are still most "accessible to middle and upper-income families" (p. 3).

Constructivism: Defining Intelligence and Improving Problem Solving

Efficiency through social programs and efficiency through standardized exams both had the same objective: increase student achievement measured in terms of intellectual achievement. However, the perceived relationship between social development and intellectual development discussed thus far has been, at best, sequential.

Rather than viewing solutions to cognitive problems as secondary to social problems (or not even related to social problems), a new perspective is needed in order to offer an excellent education to economically disadvantaged students. The Constructivist Theory of learning, pioneered by such prominent psychologists as Jerome Bruner, offers a systems perspective of intelligence (cognitive processes) as a "social construct, created through social activities" (Lee & Prajna, 1995, p. 149).

Windschiltl (1999) categorized the literature on constructivism as either cognitive or social constructivism. Jean Piaget has been the inspiration to many of the cognitive models, investigating "how learners, as individuals, impose intellectual structure on their worlds"(p. 190). Social constructivism, on the other hand, suggests that "people construct knowledge in the presence of others who collectively constrain the environment with tools such as language, with conventions such as predetermined concepts, and through accepted practices for creating and judging knowledge" (Windschiltl, 1999, p. 190). A third constructivist approach is a combination of cognitive and social constructivism: "knowledge is personally constructed and socially mediated" (Windschiltl, 1999, p. 190). This third approach avoids the dualistic trappings of western civilization's mind-body dilemma by recognizing that cognition and social context interact and mutually influence the development of intelligence.

Intelligence: The Importance of Environment

Lee and Prajna (1995) compared two prominent perspectives of intellectual development, psychometric and cognitive. The authors defined the psychometric perspective as relying on measurements of intelligence, such as Alfred Binet's IQ test. The cognitive perspective defines intelligence in terms of knowledge and reasoning

processes, as prevalent in more recent theories such as Piaget's theory of cognitive development and Gardner's theory of multiple intelligences. Lee and Prajna (1995) argued that intelligence is not so much a physical part of the person as it is, once again, a "social construct, created through social activities" (p. 19). Sternberg (1996) made a similar argument when he wrote that "successful intelligence" was more important than I.Q (which only measures academic intelligence). Sternberg argued that successful intelligence relates to the acquisition and use of knowledge needed to succeed in a particular environment. The social context determined the intellectual skills developed based on what was needed to succeed. Learning, therefore, is "successful intelligence" and has a social context.

Brooks and Brooks (1999) offered a definition of learning that demonstrated the connection between cognitive development and social setting:

> Learning is a complex process through which learners constantly change their internally constructed understandings of how their worlds function. New information either transforms their current beliefs – or doesn't. The efficacy of the learning environment is a function of many complex factors, including curriculum, instructional methodology, student motivation, and student developmental readiness (p. 20).

On a less traditional side, researchers of brain-based learning theories weighed in on the connection between cognitive development and social context. Although the scientific approach might seem to favor a more biological explanation, many researchers of brain physiology agree with psychologists, that development of intelligence is predominantly environmental. An important book in defining brain-based intelligence and its significance to education is Robert Sylwester's A Celebration of Neurons: an Educator's Guide to the Human Brain (1995). In one theme discussed in this book, Sylwester argued that there are two major systems the brain uses to define self and

society within the time/space environment. The first is the value-driven system that "focuses inwardly on our survival, emotional, and nurturing needs. This system regulates much of our innate knowledge (Sylwester, 1995, p. 43). Sylwester writes that it is structurally located in the limbic system, the area that regulates what Gardner would call intrapersonal and interpersonal intelligences. This area of the brain is developed only with great effort. The externally driven system, the second of the two, focuses outwardly on the environment's continuously shifting space/time demands and is located in the cortex where networks are easily altered (Sylwester, 1995). Sylwester physically places Gardner's other intelligences (spatial, kinesthetic, logic-mathematical, linguistic, musical, and naturalist intelligences) in this region, suggesting that these intelligences can be learned and improved through manipulation of the external environment (i.e. education). Sylwester referred to tomography to identify general locations of the intelligences. Tomography, or brain-mapping, is a procedure involving a subject being attached to a computer and brain activity monitored while various activities are performed (Nichelli, Grafman, Pietrini, & Always, 1994).

David Phoenix (1999) also investigated the relationship between cognitive development and social context, but looked at the how environment can limit growth. Phoenix argued that the research to date overwhelmingly supports that intelligence levels are often hindered by environmental conditions, and therefore he believes students from such circumstances will need to exert "effort" to reach their full potential.

Whether Constructivist Theory or brain-based science many modern theories of intelligence seem to agree that environment plays a significant role in cognitive development. Bruer (1998) specifically credits "enriched environments" as having "an

unmistakable effect on brain development"(p. 15). An "enriched program" is one that promotes "basic skills and higher-level thinking" (Cotlin, 1999, p. 2). The key words here are "enriched environment" because it may be the quality of environment, the characteristics of an environment that influence cognitive development. The presence or absence of an enriched environment will likely influence the level of cognitive development that, as discussed earlier, separates the academic preparedness of economically disadvantaged students from their middle/upper socio-economic classmates.

The Impoverished Environment: Social Influences on Cognitive Development

As early as the 1960s, poverty was identified as a culture "with its own structure and rationale, as a way of life which is passed down from generation to generation" (Lewis, 1965, p. xliii). Children from poverty have been labeled as disadvantaged. The term disadvantaged implies that something needed is missing, or hindered by the culture (as discussed earlier with Phoenix). Work by psychologists, sociologists, and educators dealing with the culture of poverty, has revealed important insights about how children from poverty learn and how they are disadvantaged. As a result of a lack of enriched experiences that develop critical thinking and communication skills in early childhood, many children from poverty enter the school system with a developmental disadvantage in problem solving abilities and language skills (Gratz, 2000; McNeil, 1998; Payne, 1995). According to Slavin (1998), the environment is less nurturing, both physically and emotionally, compared to middle and upper income environments. What this exposure to inadequate experiences translates to is a diminished chance of academic

achievement: Students from poverty begin school at risk of academic failure (Leroy & Symes, 2001; Payne, 1995).

If the quality of a child's earliest experiences has such influence on future development and potential to succeed academically, intervention should be implemented at an early stage to stop the process of failure before it begins (Slavin, 1998; Payne, 1995). Just as free/reduced lunch programs and insurance programs were designed to meet the health needs of children from poverty, Head Start and other preschool programs were created to offer needed educational experiences to children from poverty. Although preschool participation is increasing for poor children, "poor children are still less likely to participate in preschool programs than are higher income children" (National Household Education Survey, 1999, p. 35). Despite positive attempts to counter problem solving and language disadvantages, many children from poverty still begin school disadvantaged.

Windschiltl's definition of social constructivism stated that language and predetermined concepts are cultural tools that constrain an environment and hinder development. Language, therefore, is an important component of cultural identification and cognitive development. Language acquisition for children from poverty generally results in a limited vocabulary and a casual register that will apparently meander meaninglessly through a topic (Payne, 1995). The meandering path of dialogue is perceived as less intelligent than the sequential dialogue of the school's formal register. Leroy and Symes (2001) evaluated the result of limited vocabulary and languages skills: "If children have limited opportunity to learn language, organize perceptions, and develop other higher order cognitive processes, their ability to solve problems and think

independently is negatively affected"(p. 46). In this evaluation, Leroy and Symes hinted that limited language leads to limited cognitive development.

Research by Lewis (1999) indicated that students who did not develop strong language and reading skills by the third grade had higher levels of absenteeism. Denti and Guerin (1999) concluded that absenteeism has been one of the strongest school data reports that predicts dropping out. Thus, the familiar link between poverty, literacy, absenteeism, and drop out rates within many low-income communities is visible.

Bracey (1999) reported an "economic disaster" for minorities who were employed at a level of 30% compared to 53% for Whites after dropping out. This research provided insight that the completion of high school not only represented student achievement, but impacted life achievement. The English Journal (1999) published an article, "Hispanic Dropout Mystery," that reported that the dropout rate for Hispanic students had risen to 30%. Once again, the dropout rate for Hispanics likely has more to do with socio-economic status than ethnicity. The problem solving skills necessary to achieve literacy by the third grade, therefore, are the skills that minority and economically disadvantaged students need to develop in the early years of education to avoid loss of motivation and a trajectory of low academic performance. Programs aiming to remediate the cognitive needs of economically disadvantaged students might target the development of verbal reasoning skills as a link to future academic achievement.

Economically Disadvantaged Children in the School Environment: Cognitive Influences on Social Perceptions

Stipek and Ryan (1997) investigated whether motivation or cognitive skills was the main issue for economically disadvantaged students' difficulties in the first years of

school. Children were administered cognitive tests to assess creativity, memory, language, and problem-solving skills, as well as basic skills related to reading and mathematics. The pretests were administered at the beginning of preschool/kindergarten and posttests were administered at the beginning of the following school year. The researchers reported "significant SES differences were found on all eight cognitive assessments given, including tests of basic reading related and number skills, problem solving, creativity, memory, and language skills" (Stipek & Ryan, 1997, p. 720). Although large gaps were found for all the cognitive measures, among the largest gaps were the tests of basic skills (related to math achievement and reading achievement). The authors concluded that the study "revealed almost no motivation deficits for the economically disadvantaged children" (Stipek & Ryan, 1997, p. 721). The authors concluded that "failure to improve cognitive competencies of children before they enter school appears to set many disadvantaged children on a trajectory of low academic achievement and all of the negative social and personal outcomes that are associated with poor school performance" (Stipek & Ryan, 1997, p. 722).

A study by Swanson and Alexander (1997) also investigated the relationship between reading and cognitive skills. The study compared the cognitive processes of learning disabled students and skilled readers. They concluded that the learning disabled students were deficient in several cognitive processes as compared to the skilled readers, suggesting that cognitive development is at the foundation of reading comprehension.

The fact that Stipek and Ryan had to compare cognitive development to motivation demonstrates the existence of a debate about why students develop a lack of motivation. The Stipek and Ryan study concluded that motivation was high for all

students and that for some students the lack of motivation (the hindrance of motivation) was likely developed from within the school environment as a result of cultural bias. Ellen Winner cited an example of how cultural bias on the part of the teacher led to low self-esteem and underachievement. Winner wrote about a student named Alex who displayed many of the characteristics of a child from poverty. Most of Alex's teachers did not like him because of his behavior, including one teacher who thought Alex should be tested for retardation. Subsequently, Alex scored a 158 on an I.Q. test (Winner, 1996). Alex's "low income behavior" did not meet the norms of the middle class culture of the faculty, which influenced teacher perceptions of Alex's ability.

Alvidrez and Weinstein (1999) examined low and middle class cultural perceptions through the relationship between preschool teachers' appraisal of intelligence and future high school performance. This longitudinal study examined teacher perceptions of children at the ages of 4, 6, 11, and 18. Students from higher socioeconomic status who were more assertive, or who demonstrated more independence, were perceived more positively than the I.Q. score predicted. On the other hand, low socioeconomic children, and those perceived as immature (a common misperception of children from poverty, as observed by Payne, 1995), were perceived more negatively than the I.Q. test predicted. The study concluded that when socioeconomic status was controlled, preschool teachers' perceptions of I.Q. significantly predicted G.P.A. and S.A.T. scores fourteen years later. In other words, Social Darwinism was alive and well as low socio-economic students were perceived to be less intelligent than high socio-economic students. Winner's example of Alex, and the Alvidrez and Weinstein study, demonstrated the "trajectory of low academic achievement and all of the negative social

and personal outcomes associated with poor school performance" that Stipek and Ryan concluded.

The disadvantages that developed from the culture of poverty must be addressed in the manner in which they developed, socially. While impoverishment is determined by finances, a study by Mayer (1997) emphasized that money alone would not solve the already existing social and cognitive disadvantages in place. Mayer collected data longitudinally over several years from several organizations that collect data on children, and children whose mother's are on welfare. Mayer created a statistical model for an income increase from $15,000 to $30,000 a year. She found that extra money was spent on food at restaurants, bigger living spaces, and automobiles. Mayer concluded that the increase in income meant children were better housed and fed, but not necessarily better educated and non-monetary factors play a bigger role than previously thought in determining how children are able to overcome disadvantage (Mayer, 1997).

In light of Mayer's study, the governmental attempts at financial efficiency through free lunch and insurance programs may solve important basic needs, but they do not necessarily translate to children being "better educated." Programs like Head Start more accurately target the social issues behind cognitive development. However, low enrollment is still a problem for most economically disadvantaged children (National Center for Education Statistics, 1999). This is where the continued implementation of the value of efficiency may compound the problem for students from low-income families. Implementing standardized curriculum could rhetorically be promoted as equity, but when educators structure classroom lessons and curriculum "to ensure that all students learn the same concepts at the same time, each student still constructs his or her own

unique meaning through his or her own cognitive processes" (Brooks & Brooks, 1999, p. 21). In the case of economically disadvantaged students, the deficiency of cognitive development influences how they construct, or don't construct, meaning in the middle class social setting of school.

Constructing Learning From the Values of the Culture of Poverty

Constructivist Theory contends that learning is a social, as well as cognitive, process, and students construct meaning from new experiences that are understood within the context of his/her current beliefs (Brooks & Brooks, 1999). In order to develop the problem solving skills that economically disadvantaged students need to increase their chances of academic achievement within the current climate of high-stakes testing, an understanding of the dominant aspects of the culture of poverty is needed.

According to the observations of Payne (1995), the learning style of economically disadvantaged students is more spatial. Also, unlike the achievement orientation of middle class culture, the culture of poverty is entertainment oriented. Oscar Lewis (1965) alluded to this observation as well. The focus on entertainment was a protective mechanism to deal with hardship in so many other parts of their lives. Fellin (1995) pointed out another aspect of poverty, from a sociological point of view, which makes achievement difficult for children from poverty. Fellin described the sociological phenomenon of "compression." Fellin and Payne are in agreement that the culture of poverty has a very material view of children. Because of a lack of material goods, children are the most valued possession of parents. It is not uncommon for parents to have a clear and obvious favorite child. Often times, achievement is treated as a threat, because if a child succeeds, he/she might move away. As a result, children from poverty

are often ridiculed for academic achievement. The ridicule and criticism can be enough for a child to deter efforts that lead to academic achievement. This, according to Fellin, is compression. One way to counter compression is to provide the students with a social setting that counters the compression they experience off campus (Fellin, 1995). An intervention, or remediation, for cognitive development for economically disadvantaged students would be more beneficial if it were spatial, entertaining, and could provide a social support system to deal with compression.

The Value of Games

An area receiving increased attention in the last few years, regarding methodology for teaching problem solving skills, is a concept known to psychologists as "play therapy" (Kaduson & Schaefer, 1997; Kuhn, 1995). The argument, according to Fleisher (1997), is that games allow students to explore the fun of learning while developing high level thinking skills. The game of chess was used as part of a child psychotherapy program for reinstating orderly, logical, goal-directed thinking for children who had been traumatized (Smith, 1993; Fried, 1992), and in Italy as rehabilitation for psychiatric disorders (D'Ammore, Pacifici, & Bollea, 1998). However, the term "play therapy" is more often associated with psychotherapy. In terms of pedagogical practice "learning through play" is more descriptive. Learning through play has been an area of intense focus in recent years by sociologists, psychologists, and educators alike. Play is believed to be a significant component of social and cognitive development (Meckley, 1994; Aycock, 1992). Just as chess has been used to assist traumatized children, games have been studied as ways to develop creativity and critical thinking skills (Tuttle & Paquette, 1997).

Play has caught the attention of researchers in biology and brain physiology. According to Arnold Scheibel, an evolutionary biologist, the brain has evolved and wired itself to best respond to novelty. Games actually strengthen intellectual and creative abilities, especially games that are unique every time you play them (Franklin, 1998). Sylwester (1995) wrote about games from a brain researcher's perspective: "since it is biologically important to continually activate neural networks in order to maintain their efficiency, we humans developed the arts and humanities that use enjoyable and challenging games and activities that metaphorically allow us to practice skills and maintain memories that are important to our survival" (p. 53).

Perhaps more importantly, for this review of literature, play is a social endeavor, and cognitive skills being developed within the context of social interaction is the premise of Constructivist Theory (Lee & Prajna, 1995). Also, games in general meet the entertainment value of economically disadvantaged culture. But what kind of game would be best for economically disadvantaged students to develop problem solving skills?

Gobet and Simon (1992) concluded that pattern identification played a key role in problem-solving when investigating chunking theory of expert memory, so games that involve pattern identification are likely to promote problem-solving. More recently, Fogarty (1997) argued that pattern development helped problem readers keep information in short term memory long enough for it to be transferred to long-term memory. Holly (1997) argued that the best way to "model patterns" and "investigate patterns" was through the use of concrete objects. Leamnson (2000) also argued that in order for learning to take place, the problem solving activity should be paired with a hands-on

activity. Therefore, the game used to teach pattern identification and problem solving to economically disadvantaged students should be a concrete (hands-on) activity that is spatially oriented.

According to Franklin (1998), the card game bridge and the board game chess are ranked as the top two games that require higher level thinking skills and problem solving (also in Charness, 1997). Forbes magazine published an article in 1995 detailing how several multi-billion dollar corporations evaluate aptitudes in strategy games like chess and bridge as part of their hiring practices (Ross, 1995). However, of these two games, only chess is spatial in orientation, and therefore, more in line with the cultural norms of children from poverty. Additionally, chess has a long history of research in association with thinking skills, going back as far as Alfred Binet and the development of the intelligence quotient. Just as play therapy move from the field of psychology to learning theory in the field of education, psychologists have used chess players to study the machinations of problem solving and related cognitive processes. The inference is that chess players have well-developed problem solving skills and the game of chess is a problem solving activity worthy of study. Since problem solving is also a skill coveted for academic achievement, a natural question to derive from psychologists' chess studies is whether chess can be used to develop problem solving for students deficient in problem solving.

Chess and Problem Solving: From Psychologist's Lab to Educator's Classroom

Chess and Psychology

Beginning in 1893 with Alfred Binet, chess became a favorite medium of psychologists for investigating the workings of the human mind. Binet used blindfolded

chess players to study memory. In fact, chess was the primary tool of Alfred Binet's investigations of intelligence that led to his development of the theory of intelligence quotients (Russell, 1981). Even Freud once compared his developing theory of psychoanalysis as being similar to "the steps required to master chess" (Ferguson, 1995, p. 1). Psychologist Djakow studied grandmaster chess players and concluded that they relied heavily on visual memory and logical thinking (Ferguson, 1995).

Chess and the Study of Memory

George (1988) conducted a study on the effects of levels of analysis on visual memory. The purpose of his study was to demonstrate a connection between superior visual memory and various levels of semantic thinking through the analysis of chess positions. The findings demonstrated that levels of analysis exist within semantic processing and that the strength of a memory depends upon the number of levels used together (George, 1988).

The study of memory was also conducted within the context of expertise development. Schneider, Gruber, Gold, and Opwis (1993) found that the recall of expert children chess players for meaningful positions was greater then novice adults. This suggests a situational expertise based on prior experiences in chess rather than some biological developmental stage. The results showed that prior knowledge contributed to expert memory. This too is consistent with constructivist theory.

Considerable work has also been done on the chunking theory of memory (chunks being defined as patterned clusters of pieces). Gobet and Simon (1998) argued that ability differences of chess players could be attributed to the storage of thousands of chunks in long term memory. Gold & Opwis (1992) argued that cluster analysis was the only

theory that provided information on content, form, and organization of knowledge. Chunking theory based on patterned clusters emphasizes pattern identification as an important component of memory, which in turn is important to problem solving.

Gobet and Simon (1996) studied the recall (memory) abilities of chess players from beginners to experts. The purpose of the study was to determine if chess skill was limited by the size of short-term memory. The study was conducted within the framework of the chunking theory of memory. The researchers concluded that the chess players used long-term memory structures as well as chunked short-term memory to store information. Essentially, these psychologists were describing the relationship between short-term and long-term memory that interact to determine meaningfulness of new information. As new information is acquired, it is held in short-term memory and then compared to the experiences and knowledge held in long-term memory. The extent of the meaningfulness of the new information affects the degree to which the new information is stored in long-term memory (Sylwester, 1995 made a similar brain-based argument for memory).

Hoffman, Prather, Wells, and Groan (1998) conducted a study of chess players and non-chess players to investigate the impact of meaningfulness on memory storage. Players and non-players alike were required to remember chess positions in a virtual environment. The non-chess players could not report a difference between meaningful and meaningless positions. However, tournament chess players were able to remember positions that they had identified as meaningful. The tournament players scored as low as non-chess players for meaningless positions. The contextual meaning was important to memory. For educators, this suggests that content that is not relevant to the

experiences, and social backgrounds of students, is more difficult to be retain, or learn. Prior knowledge and experiences and how they relate to current situations (meaningfulness) impacts memory, and therefore, problem solving.

Saariluoma and Kalakoski conducted studies of blindfolded chess players in 1997 and again in 1998. The purpose of both studies was to investigate the role of mental imaging in memory processing. In both studies meaningfulness of the positions to the blindfolded chess players impacted their ability to reconstruct mental images and the level of recall.

Chess and Motivation

Horgan (1992) wanted to investigate the relationship between motivation and metacognition. Similar to a study she conducted with students predicting grades on exams, Horgan argued that "increased experience and skill in tournament chess is associated with some significant changes in the way success and failure are interpreted – changes that enhance motivation" (p. 5). Horgan (1992) wrote that "attribution plays an important role in motivation and hence in cognitive development" (p. 5). She discussed the asymmetrical way people tend to attribute success to internal causes and failure to external causes. The ability of a child to "calibrate" is a metacognitive skill that could enhance motivation, and, therefore, academic achievement. She argued that students tend to be overconfident after success and under-confident after failures.

To test her theory, Horgan studied investigated the predictions of 87 nationally ranked chess players between 6 and 15 years of age. The researcher looked at predictions in relation to age and skill. Patterns in the predictions of the players emerged. As the age of the players increased, "players remained overconfident after wins, but became less

confident after losses" (Horgan, 1992, p. 6). However, as skill level increases students were less overconfident after wins, yet retained levels of confidence after a loss. The students with higher skill levels had learned not to become too confident after a win or too discouraged after a loss. According to the researcher, these students were more calibrated. Horgan cites work in which attributions are usually outcome-based (the most recent outcome). In other words, attributions are based on single events. Horgan (1992) argues that chess players may become more calibrated because of the "many, many games" played "within a short period of time and [they] always have a set of games in mind when they think about their ability" (p. 6). Finally, Horgan noted that from her other research on calibration and prediction of test grades, well-calibrated students had better time management skills and studied less than the less well-calibrated students who received the same grades (Horgan, 1992).

Expertise in Chess: Knowledge or Thinking

Horgan, Millis, and Neimeyer (1989) examined similarity judgements with chess players of different skill levels and determined that experts were more efficient in the processes of decision-making on a series of chess problems. Holyoak (1995) investigated the nature of problem solving, arguing that problem solving depends on general cognitive abilities (such as language, sequencing, memory, categorization, judgement, and perception). Holyoak suggested that the understanding of problem solving would benefit from research on the acquisition of expertise in such fields as chess or physics.

Cooke, Atlas, Lane, and Berger (1993) studied the acquisition of expertise in 20 chess players. The researchers wanted to determine the difference between novice and expert chess players' ability to reconstruct complex piece positions on the board. The

researchers concluded that the expert chess players were able to reconstruct at a much greater level because of a high-level of conceptual knowledge. In other words, the expert players had a vast experiential background of conceptual knowledge that made the new positions presented easier for them to remember. This is consistent with the Constructivist Theory of learning in that learning is constructed from relating new information to personal experience and previously acquired knowledge.

An earlier study by Saariluoma (1990) dealt with the role of apperception in problem solving of chess players. The author argued that when deciding on a move, the chess player uses recognition-association to select the most promising move. Recognition-association means that the player is looking for a pattern that they have experienced before, because if they remember the outcome of the prior pattern then they can decide if the current situation would deliver a similar outcome. Saariluoma (1994) again addressed the issue of apperception as a means to argue that chess ability is more dependent on acquired knowledge than long range planning. He argued that long-range planning is based on poorly defined concepts such as weak square, or space advantage. His experiments with chess players concluded that chess skill relies on pattern recognition rather than thinking ahead. This is similar to the distinction between knowledge and thinking that Vasyukova had to make. These chess studies kept emphasizing the difference between thinking and knowledge. Knowledge was a skill based on experience, but thinking was true problem solving because it was application of knowledge and skills to new problems.

Several other studies using chess players investigated how the mind works in the development of expertise. A question that many of them wanted to answer was the

relationship between skill and experience in the development of expertise. Horgan and Morgan (1990) studied 113 children who played competitive chess. They concluded that improvement in skill was related to experience. The longer someone is involved in an activity, the more likely he/she is to improve skill level. This is relevant to the study of cognitive development of economically disadvantaged students, especially in the early years of school, because keeping them from becoming unmotivated could keep them engaged long enough to develop the skills necessary to achieve.

Reynolds (1992) studied high rated US Chess Federation players, and De Groot, Gobet, and Jongman (1996) made the same conclusion regarding the importance of experiential knowledge. Gobet and Simon (1996) added an interesting twist to these types of studies by studying the play of grandmasters playing simuls (simultaneous games against multiple other grand masters) compared to a traditional tournament game of one person versus another. The variable was the amount of time available to think ahead. In the simultaneous games the master player had to rely more on experiential knowledge because of the less time available to plan ahead. The regular tournament game, however, had plenty of time for planning ahead. An evaluation of the choices showed that the skill demonstrated in the simultaneous games was only slightly lower than during the regular tournament game. The researchers concluded that expertise problem solving in chess had more to do with comparing new information to prior knowledge than time to plan ahead.

Chess Expertise: Search or Pattern Identification

Hegarty and Kozhevnikov (1999) examined the relationship between spatial and visual imagery and mathematical problem solving. The results indicated that spatial

representations were positively correlated with success while pictorial representations were negatively correlated. The authors suggested that math students create spatial representations of the relations between objects in a problem. Several studies were conducted in the early 1990s that established the need for spatial ability in chess (Frydman & Lynn, 1992; Saariluoma, 1992; Horgan & Morgan, 1990).

Chess has also been used to study decision making as an act of problem solving. Klein, Wolf, Militello, and Zsambok (1995) studied high and medium skilled chess players, testing them for the quality of options they chose in a selected chess situation/position. The researchers learned that the chess players were able to find satisfactory options very quickly. As part of decision making, Fu (1995) studied the different types of problem solving strategies implemented in chess decision making. Using 44 chess players, Fu determined that three strategies were represented: trial and error, concentration, and decomposition. Wang and Fu (1997) pulled the previous two studies together when they studied 65 college age chess players for the amount of time needed to solve problems of differing levels of difficulty. Identifying the problem was determined to be the key to the rate of solving the problem, and therefore, a component of expertise.

Two models for thinking have been debated among psychologists regarding how expertise is achieved, search model and pattern-recognition model. Again, chess players were the subjects of the investigations. The first model proposed was De Groot's 1978 pattern recognition model, based on studies of chess players' recognition of typical or atypical positions (Gobet, 1998). De Groot argued that players of different skill levels do not differ in their thought process (other than depth and number of options considered).

Holding (1992), disputed De Groot's conclusions, arguing instead that skill difference does exist and does influence problem solving. Freyhof, Gruber, and Ziegler (1992) completed a study that confirmed De Groot's findings that pattern-recognition theory explains expertise. Gobet (1998) replicated the 1978 De Groot study and concluded that the distinction between search and pattern recognition models was not necessary, as he found both in his study. He argued that recognition and search are interrelated: the choices and depths of searches are dependent upon the level of recognition. The results of the 1998 replication study are similar to the Gobet and Simon 1996 study, and all the studies involving the relationship between knowledge and thinking. In each of these studies expertise develops in a framework similar to what educators would call constructivism: building new knowledge through problem solving.

Chess and Social Skills

Although psychologists Neverkovich, Samoukina, and Kuchurnova (1996) studied reflective ability in young chess players, very little rigorous research has been attempted on the social benefits of chess for students. Most of the information available comes from quotes and opinions based on personal experiences, but not from a study of planned qualitative research. Some of these quotes are included here because they do offer insights, but, unfortunately, the literature was lacking evidence of research. For many students, playing chess is first about social interaction rather than cognitive competition. Darnell Faust was the top chess player at Orr High School on the West side of Chicago, considered one of the worst schools in the state of Illinois based on standardized testing scores. The school ranks near the bottom of nearly every category. Yet, Darnell led one of the strongest chess teams in the state. Interestingly, he focused on

the competitiveness of chess, rather than any purposed academic benefits: “Chess is like fighting…Outside you use your fists, but here you use your head” (Terry, 1995).

At Roberto Clemente School in New York, assistant principal Joyce Brown was also interested in reducing incidents of fighting (Palm, 1990. She kept data on incidents of suspensions and altercations of students who became involved with the school’s chess program. Her personal data indicated a 60% drop in the number of incidents with these children (Palm, 1990). Jerome Fishman of C.J.H.S. 231, Queens NY, also saw the social benefits of participation in chess. He said that “whenever we get a child transferred from another school who may have maladaptive behavior, our principal suggests chess as a way of helping him find his niche” (Palm, 1990, p. 1). These observations on chess were made possible by development and implementation of the Chess in the Schools program that began in New York City.

Chess in the Schools, founded by a Mobil Oil executive and Bruce Pandolfini, sent experienced chess instructors into Harlem, Bedford Stuyvesant, and the south Bronx. Many of the students attending the chess instruction had failed at intellectual activities (academics). According to comments made by teachers, reading and math scores went up and children began looking forward to being at school, because they felt confident in their ability to succeed. Unfortunately there was no researched data to support these observations. P.S. 70 in the Bronx, one of the poorest elementary schools in the nation, hired chess master David MacEnulty full time and provide chess classes to all 1700 students (West, 1993; West, 1994). Currently, affiliates in Chicago, Dallas, Richmond (CA), San Francisco, Tuscon, and Seattle are continuing the work of Chess in Schools.

The effect of chess on economically disadvantaged students was observed at CES 70 of the South Bronx, where MacEnulty was hired to make chess classes a part of the curriculum. The district in which CES 70 is located has a 97% poverty rate (Killigrew, 1998). Teachers at the school said that the chess kids "are more disciplined, better behaved, more focused, and more confident" (Killigrew, 1998, p. 55). Despite CES 70's high poverty levels, they have produced NYC Elementary Chess Champions, NY State Primary Chess Champions, and Junior High National Chess Champions. Even without the championships, many students displayed new levels of confidence and a belief that they have many opportunities available to them (Killigrew, 1998, p. 55). The district administrator for MacEnulty's school believed that chess offered the predominantly Hispanic and African American, impoverished students the "habits of mind" that are "key to overcoming the obstacles to academic success they face each day" (West, 1993, p. 2).

This program has received considerable notoriety, but, unfortunately, does not yet have research data to document the benefits of the chess instruction to the students. However, campus personnel observed something in the students' attitude toward themselves and school, a sense of control over their own destiny. In chess, the student has control over the cognitive decisions acted out on the chessboard, and therefore, determines his/her own fate.

The connection between that sense of control and cognitive achievement has been studied in a learning theory called control motive. The cognitive goal of problem solving has been related to the affective goal of control motive in that "problem solving begins when motivation is aroused and presses for satisfaction" (Friedman & Fisher, 1998, p. 219; Sylwester, 1995). Evidence from research on enlisting the control motive suggests

that people who perceive that they have control over their outcomes "feel better about their life and their environment" and "perform better in problem-solving situations" (Friedman & Fisher, 1998, p. 211). Sitpek and Ryan (1997), once again, concluded that motivation levels of children entering school did not differ, but the cognitive skills differed greatly. They believed that motivation declined within the school setting. According to Lewis (1999), by third grade the motivation levels of many economically disadvantaged students seem to drop off dramatically. Perhaps this is due to the perceptual biases discussed earlier. Perhaps entering school cognitively behind others places the students in an environment where they do not see improvement in comparison to others, causing what Wynn-Dancy and Gillam (1997) called "utilization deficiency." Kennedy (1998) argued that chess helps marginalized students' perceptions of themselves as being intelligent, increasing motivation to persist in the face of problems. Perhaps the new culture of chess at CES 70 regenerated some of the lost motivation of these economically disadvantaged students. Using chess as a heuristic to develop the control motive might be the type of research on the relationship between chess and social development that needs to be done. Something was happening at CES 70 in the Bronx, but there simply has not been data collected to make evaluations.

The literature on chess and cognitive development, however, has a rich history covering over one hundred years. Therefore, this review of literature needs to investigate further the relationship between chess and cognitive development in the schools.

Chess and Cognitive Development in Education

A 1991 doctoral dissertation by Anna Van Zyl is a good example of the ambitions of many researchers to find evidence of a connection between chess and learning. Van

Zyl was interested in the possibility that chess could contribute to "intellectual actualization". To study this, the researcher created an experimental group of 80 chess players who competed in tournaments for their respective schools and a control group that did not play chess. Participants were categorized by age and IQ pretest scores. Statistical analysis was completed to compare changes in IQ scores, performance on the different standards levels of mathematics, and language abilities. The IQ posttest revealed a statistically significant improvement for the chess players beyond the .05 level of significance. In mathematics, three different levels were evaluated. At the level of standards 3-5 there was no significant difference, but at the higher 6-8 levels chess players' results were significantly higher. All participant scores went down at the higher levels, but the chess players scores dropped gradually while the non-chess players' scores "deteriorated drastically". The researcher found no difference between the chess players and non-chess players in language performance.

After several years of psychological research in chess, linguist John Artise (1976) wrote about the human cognitive processes he believed to be associated with chess: memory improvement, logic, observation and analysis, and operant conditioning. Of these, he believed operant conditioning to be of the most value:

> Operant conditioning...this is by far the most important aspect of chess which directly relates to human learning. In human psychology, operant conditioning involves the learner actually doing, observing, and responding to the stimuli presented to him. In chess the same holds true. The player makes moves based on his knowledge of the rules, his analysis and observations and above all, his judgement. After his opponent's reply, he sees the results of his thought process. From this experience he learns. He learns from operating on what he has analyzed. In a way chess is more complete than most college studies. In many subjects the learner never gets a chance to operate on what he observes and analyzes. Thus, learning is incomplete and the learner gets turned off to further learning. In psychology parlance, he becomes negatively reinforced. In chess,

> however, the learner receives positive reinforcement. He obtains immediate knowledge of the results. (Artise, 1976, p. 12).

Although Artise was observing from a behaviorist perspective, he did in essence describe chess in the context of Constructivist Theory in which learning takes place in a specific situation. Putnam and Borko (2000) explained this situative perspective on cognition: "knowing and learning are situated in physical and social contexts, social in nature" (p. 12). The chess player in the quote by Artise "learns" from acting on the interactions with his/her opponent. Learning was taking place from the social interaction.

Three interesting studies were conducted comparing field dependence and field independence learning styles. These studies addressed the difference between field dependence and field independence, which style was more often associated with academic achievement, and whether or not chess could influence the style associated with academic achievement. Field dependent students tend to have "difficulty analyzing a pattern into different parts, or monitoring their use of strategies to solve problems" (Woolfolk, 1998, p. 134). Field independent students, on the other hand, "are more likely to monitor their own information processing…and are able to analyze a pattern according to its components" (Woolfolk, 1998, p. 134).

Diane Horgan (1987) used a sample of 24 elementary students and 35 secondary students to compare the way children perform complex cognitive tasks with the way adults perform similar tasks. She found that while the adults tended to work from a focus on details to a more global focus, the children began with a more global focus toward a detail focus. In this research, Horgan used chess to study the ability of children to learn to think clearly. She argued that this skill can greatly benefit later intellectual development (Horgan, 1987).

More recently, Tinajero and Fernanda (1997) conducted a study to investigate the differences in academic achievement between field dependent and field independent students. In this study field dependence and field independence as cognitive styles were examined. The researchers studied 408 students (nearly equal in number of boys and girls between the ages of 13 and 16) who were identified as field independent or dependent based on the Rod and Frame Test and the Embedded Figures Test. Using the ANCOVA statistical procedure, the researchers concluded that both boys and girls identified as field-independent outperformed field dependent students in all subjects.

According to the research by Tinajero and Paramo, the students with the likelihood of monitoring their own processing and identify patterns had higher levels of academic achievement (Tinajero & Fernanda, 1997). The importance of pattern identification is similar to the psychology discussions earlier in this review of literature.

In a related study, Smith and Sullivan (1997) completed a pilot investigating the effect of chess instruction on the level of field dependence and/or independence of students. The hypothesis was that chess could help students develop thinking skills that allow them to move from global to detail thinking when it is needed in academic work. Using the Group Embedded Figures Test (GEFT) as a pre and post test, the transition to field independence was statistically significant. However, the sample size of this study was well under 30, and therefore can only be considered an investigative study. The authors mentioned that the study warranted further research on this topic. The question was also raised about the field dependence or independence of economically disadvantaged students. When coupled with chess instruction, this could be an interesting study to compare the learning style differences between economically

disadvantaged students and the learning styles that are more successful in school (field independence). Nevertheless, the researchers investigated the use of chess to move from a global perspective of problem solving to the more academically successful detailed perspective.

Chess in Schools

In 1973-74, Dr. Albert Frank conducted a chess and aptitudes study at the Uni Protestant School in Zaire. The sample of 92 students between the ages of 16-18 was randomly selected from the humanities program and divided into an experimental and control group of 46 students each. Albert was interested in finding out if the ability to learn chess was due to spatial aptitude, perceptive speed, reasoning ability, creativity, or general intelligence. Participants in the study were given four different aptitude tests: Primary Mental Abilities test (PMA), differential Aptitude Test (DAT), General Aptitude Tests Battery (GATB), and the Rohrschach test. The tests were given as pre and post tests. The experimental group was required to attend a chess class for two hours a week (with after school chess play an option).

Frank wanted to determine the relationship of the various aptitudes on the development of chess skill, and he wanted to determine if chess in turn effected the further development of those aptitudes. Statistical analysis determined that for this study there was a significant relationship between "the ability to play chess well, and spatial, numerical, administrative-directional ... abilities" (Ferguson, 1995, p. 2). Frank (1974) summarized that the ability to play chess well relies on a large number of aptitudes that work together. The testing also revealed a positive influence on the development of numerical and verbal aptitudes. Frank wrote that the increase in verbal aptitude was a

surprise (Frank, 1974). This study discussed themes that appeared in the Chess and Psychology section of this review of literature: the spatial nature of chess and the connection between verbal and cognitive abilities.

Also in the 1970s, Johan Christiaen wanted to use chess to test Jean Piaget's theory of cognitive development, or intellectual maturation (Dullea, 1982). Piaget's theory contends that an important growth period between 11 and 15 years of age is when a child moves from the concrete stage of cognition to the formal stage, developing more complex logic, deduction, and judgement. Since Piaget argued that an "enriched environment" can speed up or slow down intellectual maturation, Christiaen's study proposed changing the environment with chess (the experimental group) or no chess (the control group).

For the study, Christiaen randomly selected 40 students at the Assenede Municipal School in Ghent, Belgium. The students' average age was around 11 years old, and they were divided into 20 for an experimental group and 20 for a control group. The design of the study was intended to determine if students had "progressed further towards the formal stage" (Ferguson, 1995, p. 3). Therefore, no pretests were administered, only a "posttest" at the end of 5th grade and the end of 6th grade. The students were administered the PMS tests, and Piaget's tests for cognitive development. The design intended to determine if an enriched environment (i.e. chess) could accelerate the transition from the concrete level to the formal level of cognitive development. The experimental group received 42 one-hour lessons using *Chess for Youths* as a textbook. After the first year of instruction, a statistical analysis using ANOVA showed that the experimental group of chess players had progressed further than the non-chess control

group at a .01 level of significance. The testing at the end of the 6th grade year (the second year of the study) again showed statistical significance in favor of the chess playing experimental group beyond a .05 level of significance. A drawback on this study was the use of statistical analysis for such small sample sizes.

Noted psychologist Adriaan de Groot considered the Christiaen study to be the best educational research on chess instruction and the mental development of school children. He suggested that the "playful subject matter can have a positive affect on motivation and school achievement" (de Groot, 1978, as cited in Ferguson, 1995, p. 3). The focus on Piaget's theory of intellectual development was a significant contribution by Christiaen. The biographical / demographics of the students participating in the study, however, were not provided, so while the study related chess instruction to cognitive development, it did not specifically address economically disadvantaged students.

Intellectual growth was again the focus in a 1984 study in Venezuela by that nation's Ministry for the Development of Intelligence (Gonzalez, 1989). This study tested whether chess could be used to develop intelligence as measured by the Wechsler Intelligence Scale for Children. An actual copy of the study has not yet been translated to English, but the results were reported to the Federation Internationale des Echecs (FIDE, the International Chess Federation). The Venezuelan study, titled Learning to Think Project, used a sample of 4,266 second graders. After four and a half months of chess instruction most students, regardless of gender or socioeconomic background, showed an increase of intelligence quotient (Ferguson, 1995).

In the mid 1980s, Robert Ferguson was one of the first to extend the research of Christiaen, beginning with a federally funded three year project (extended to four years

with local funding) to investigate the development of critical and creative thinking. The project was funded by ESEA, Title IV-C (Ferguson, 1986). This study focused on mentally gifted students with an IQ of 130 or above. Students were selected from grades 7 through 9 and met once a week for 32 weeks at the Bradford Area High School to pursue a challenging experience of their choice. This study, therefore, compared the development of critical and creative thinking of gifted and talented identified students based on the type of activity the student chose. Chess was one of the choices, as were computer related activities (in 1982 computers were not "user friendly" and still required significant problem solving skills). Ferguson compared changes in critical thinking and creative thinking of the chess players, the computer students, and all the students combined who did not choose chess. There was also a group of qualified students who did not participate in the Title IV-C program but did participate in the study by taking the pre and posttests. Ferguson reported that the groups spent about 60 hours total pursuing individual preferences.

Ferguson used the Watson-Glaser Critical Thinking Appraisal was used to test for critical thinking. A statistical analysis of the fifteen students in the chess group indicated an annual increase of 17.3% in percentile scores. Ferguson wrote that an increase in percentile score "indicates an above average performance" and, therefore, the Bradford chess group "significantly outperformed the average student in the country four years in a row" (Ferguson, 1986; summarized in Ferguson, 1995, p. 4). The paired samples t test was used to measure significance in change of pretest-posttest scores, and the Chi Square was used to evaluate the significance of the number of chess players with an increase compared to the non-chess players with an increase. The chess group and the chess

versus non-chess group resulted in statistical significance (p>.001). The chess versus the computer group (p>.003) and the chess versus the non-participants (p>.025) also indicated statistical significance.

In the same study, Ferguson tested creativity using the Torrance Tests of Creative Thinking. The Torrance Test measures three subcategories of creative thinking: fluency, flexibility, and originality, all of which are instrumental in problem solving. Ferguson wrote that gains in originality were expected when students are trained in creative thinking, but gains in fluency are usually "slight or nonexistent" (Ferguson, 1986; summarized in Ferguson, 1995, p. 6). The chess group results on the Torrance Test indicated significance in flexibility (p>.024), and originality (p>.01). The chess group compared to the computer group indicated statistical significance in fluency (p>.038) and originality (p>.022). The chess group compared to all participants who did an activity other than chess indicated statistical significance in all three subcategories: fluency (p>.049), flexibility (p>.05), and originality (p>.018). When the chess group was compared to gifted students not involved in the Title IV-C project, the statistical significance was the greatest for all three subcategories: fluency (p>.039), flexibility (p>.002), and originality (p>.001). Ferguson was particularly surprised by the statistical significance of gains made in fluency made by the chess group when compared to the computer group, the non-chess group, and the non-participant group (Ferguson, 1986).

In yet another study, a tri-state area school pilot study, Ferguson worked with gifted students from the Bradford Area High School. Students were allowed to self-select one of two activities. The first was an S.A.T. preparation class and the other was chess. Ferguson had an equal number of non-gifted students participate in chess. Both groups

reported statistically significant gains (S.A.T. p>.024, and chess p>.004) (Ferguson, 1986).

Ferguson (1988) returned to testing cognitive skills with another study at the middle school in Bradford, Pennsylvania. This study was later published in the *New* Horizons Online Journal (Spring 2001). Students in a 6th grade self-contained classroom were required to participate in chess. Students played daily between the end of September and the end of May and students were administered a pre and post test using the Test of Cognitive Skills Memory subtest and the Verbal Reasoning subtest of the California Achievement Tests. A total of fourteen students completed both the pre and posttests. Statistical analysis was conducted using the t-test, comparing the experimental group with national norms. The experimental group demonstrated statistically significant improvement in both Memory (p>.001) and Verbal Reasoning (p>.002). When compared to the national norm, the experimental group demonstrated statistically significant improvement beyond the .05 level of significance only in the Memory subtest (p>.001). Ferguson wrote that the students used the USA Junior Chess Olympics Training Program, with seven of the students eventually competing at the state tournament and two at the national tournament (Ferguson, 1988). None of the students had played chess at the beginning of the school year. Ferguson argued that the program was more effective for those students who demonstrated higher levels of competitiveness (Ferguson, 1988). Although this study has interesting inferences, the small sample size makes the use of statistical analysis unreliable when evaluating significance.

In the late 1980s and early 1990s, chess as an instrument of cognitive development in the school system began to gain momentum. The New York City

Schools Chess Program (NYCHESS) was founded in 1986 by Faneuil Adams, a Mobil executive, and Bruce Pandolfini, chess master and prolific author of chess instructional books. The program sent experienced chess instructors from the Manhattan Chess Club to some of the poorest schools in New York City. Between 1986 and 1990 more than 3,000 students at more than 100 campuses participated in the program. In 1990, the NYCHESS program released a report, compiled by Christine Palm on the benefits of the four-year program. No statistical methods or tests were cited. The report was based on academic and anecdotal records (of which some were reported earlier).

At about the same time as the NY CHESS program, Canadian schools actively sought chess as a means to improve math results. Quebec introduced chess into the classrooms through a math program in the 1980s. Michel Lyons developed Challenging Mathematics, which includes chess, and has been taught in most French-speaking Quebec elementary schools, as well as New Brunswick schools. Since then Quebec students have scored 15% higher than the national average on the national math tests and in 1989 New Brunswick mandated chess as part of the curriculum (Globe and Mail, 1995). In 1993, York approved chess as part of its official math curriculum beginning with the third grade (Desiato, 1995). The Canadian acceptance of chess without rigorous studies connecting chess and math scores took a leap of faith on behalf of Canadian officials. However, once implemented, data from national exams has been collected to evaluate the effectiveness of using chess in the classrooms.

The Chess in Mathematics program implemented in New Brunswick was one of the first to conduct actual research. A total of 437 fifth graders were tested after being place into one of three groups as first graders. Group A received the traditional math

instruction since first grade. Group B received the traditional math in first grade, but beginning in second grade chess and problem-solving instruction was added. Group C received the chess enriched math curriculum beginning in the first grade. The results of the study did not indicate significant statistical difference regarding basic calculations on standardized tests. However, there was significant statistical difference between Group C (math curriculum enriched with chess instruction) and Group A (no chess) in terms of the problem solving portions of the standardized test. Group C scored 21% higher than Group A on the problem-solving section, and 12% higher on the comprehension section. Another benefit of the program was the increase of students participating in the province's chess championship tournament, from 120 students in 1989 to 19,290 in 1992 (Gaudreau,, 1992, summarized in Ferguson, 1995).

Stuart Margulies (1992) conducted a study on the effects of chess on reading scores. Margulies randomly chose third and fourth graders from District Nine of New York City for forty-five minutes of chess instruction each day. Fifty-three students participated in the study. The dependent variable used was the Degree of Reading Power Test (DPR) that is given every May as part of usual district and state evaluation. Scores on the DPR between May of 1990 and May of 1991, with the intervening school year being the chess instruction period, were compared using the paired t-test. The study was continued into a second year, with the addition of computer software as part of the chess instruction. The results of the paired t-test indicated statistical significance at the .01 level. Statistical analysis was also conducted for the 22 chess team members that used the technology component the second year of the study. These student score changes were compared to 1,118 non-chess players. Statistical significance was determined at the

.05 level. Finally, Margulies compared the 22 chess team member scores against 655 non-chess players that scored high on the DPR because he was concerned about the possibility that the chess team attracted students who were already intellectually gifted and accomplished readers. The comparison again found statistical significance at the .01 level.

Margulies (1992) did not make conclusions about the results of the study, but he did offer suggestions as to why the scores increased: (a) according to chess masters, chess develops general analytical abilities that transfer to other areas, (b) teachers in the district said the students self-efficacy improved, improving their attitude about learning, (c) chess attracts participants that are already intellectually stimulated or accomplished, and (d) the skills and cognition involved in reading are related to those needed to play chess. Margulies elaborated on the fourth explanation, showing the parallels between the processes, but did not offer evidence of such a relationship. The Margulies study was well received by the district and the chess community, but the small sample size of 22 students for the comparisons to the control group of non-participants makes the statistical analysis less reliable.

More recently, a study conducted by a high school chess coach investigated the effect of chess on both math and reading scores. James Liptrap (1998) reported the results of a four-year study in the Houston area comparing TAAS reading and math score increases from third grade to fifth grade for students who played chess and students who did not play chess. The chess playing students increase in scores was twice that of non-chess playing students for reading and mathematics. The Liptrap study was administered in affluent and middle class school districts. The data were desegregated by gender,

special education, academically able, gifted and talented and regular education students. The study compared TLI scores for reading and math at third grade and fifth grade. The most significant increases came in the regular education group. There was no difference between regular education chess and non-chess groups in the third grade, but by the fifth grade the chess players had significantly higher scores than the non-chess students. The special education students showed much smaller increases, but anecdotal reports stressing self-esteem and confidence showed sharp increases (Liptrap, 1998).

While the Houston TLI study does demonstrate that chess may have an impact on student TAAS performances, which would attract the attention of many administrators in Texas, it does not address students from economically disadvantaged homes who, as discussed earlier, may be at risk because of the high-stakes standardized exams. Additionally, since TAAS exams are self-administered within a high-stakes climate where there are numerous programs to improve scores, they are not considered a reliable dependent variable.

Although the chess studies conducted by psychologists infer inherent problem solving associated with chess, the issue of transference of problem solving ability to other academic areas has been more challenging to document. Rifner (1992) specifically addressed the issue of transfer. The study was designed to determine if children who learned problem-solving skills from playing chess could transfer the skills to poetic analysis. The study had quantitative and a qualitative components. The quantitative component was the administration of pre and posttests on twelve variables associated with achievement. The only statistically significant effect was for the transfer task. The qualitative component was conducted to "determine which aspects of the problem-

solving behavior were related to the effects found in the first part" (Ferguson, 1995, p. 12). As subjects solved problems related to poetry analysis, think-aloud protocols were used and coded for "the number of search methods used, the number of goals set, the number of lines considered, the incidence of guessing, the number of unresolved negative evaluations, and the percentage of goals achieved" (Ferguson, 1995, p. 12). The data from Rifner's study indicated that "inter-domain transfer can be achieved if teaching for transfer is an instructional goal" (Ferguson, 1995, p. 12).

The literature on chess, to this point, shows very strong research in the area of psychology. Psychologists have conducted numerous studies using chess players to investigate a wide range of cognitive and metacognitive skills. The available research about the impact of chess in education on cognitive development is much less rigorous in terms of methodology and/or sample size needed for statistical analysis. Equally less rigorous has been the quality of publication for the effects of chess on cognitive development. Some of the better studies have actually been conducted as dissertation research, perhaps because of the rigor usually required for such studies.

The game of chess, because it is a game and it is spatially oriented, does address the entertainment and spatial values of economically disadvantaged students. However, the issue of compression must also be dealt with. Rifner's ten year old study did make a contribution to this review of literature's search for a solution to the dilemma of offering an enriched curriculum to economically disadvantaged students while responding to high-stakes exams. Rifner drew attention to the importance of instruction if problem solving skills from chess are going to transfer to academic achievement.

Classroom Instruction of Chess

Despite the sparseness of quality research on the impact of chess and the development of cognitive abilities within the last ten years, state legislatures have begun to pass laws allowing for chess instruction as part of recommended curriculum. On December 23rd 1992 Governor Jim Florio of New Jersey signed into law Bill #S452, "legitimizing chess as a unit of instruction within the elementary school curriculum (Katz, 1995, p. 9). Like the schools of Quebec and New Brunswick in Canada, American schools have been starting to make room for chess instruction as part of the daily schedule, not just as an after school activity. The state of Texas allows one semester fine arts credit for students identified as gifted and talented who take a chess class at their high school (West, 1993).

Chess as part of the curriculum means chess instruction. While Rifner's study was focused on transfer, he did conclude that instruction was necessary for transfer. Schiff's (1991) dissertation was the only chess study conducted with the focus on instruction. He dealt with the issue of chess instruction and its connection to improved chess play. A course of study was developed in accordance with Bloom's Taxonomy. Objectives and activities were developed as would be done for any classroom subject. A total of 48 students received chess instruction 1 to 2 hours a day for 19 days, and a pretest and posttest evaluating chess skill was administered. The researcher indicated that the study revealed statistical significance in improvement of overall chess skills of the participants ($p>.0005$). While this study attempted to investigate an important issue of chess in education, instruction versus random play, there was not a control group of chess

players not receiving instruction. This study also did not clarify whether the instructor was an experienced player or a novice, since teacher expertise is a variable in any subject.

Nevertheless, with the years of psychological research involving chess that demonstrate improved problem solving ability with increased skill, the value of chess instruction should be considered. Emmanuel Lasker (Chess Grand Master) once said, "properly taught, a student can learn more in a few hours than he would find out in ten years of untutored trial and error" (Gharbo, 1999, p. 1). In other words, instruction is a better strategy for improving problem solving abilities than trial and error.

There are also arguments from constructivist learning advocates to support a classroom instructional setting for teaching chess. Ferrari and Mahalingam (1998) wrote "our knowledge of self-as-learner is often derived from roles we take on in our culture or social practice … how we define ourselves is usually influenced, to a certain degree, by whom we are with and in which cultural context we situate ourselves" (p. 36). Lin (2001) argued that "there is a strong agreement among researchers that strategy training should be conducted in a supportive social environment" (p. 33). Payne (1995) discussed the difficulties encountered by economically disadvantaged students when entering the culture of the middle class school system. Lin (2001), however, believes that such a change of environment is necessary: "Changing social environments bring great opportunities for metacognition…people tend to engage in more self-reflection when their knowledge of the self-as-learner in routine practice is disturbed" (Lin, 2001, p. xxx). Jerome Bruner gave an example of this in his book, The Culture of Education (1996). He wrote that a chess club in a private school would not have much of an impact on the students, but a chess club in Harlem could transform the campus culture. A class for the

instruction of chess could create an enriched problem solving social setting in which strategy training could be conducted. Perhaps more importantly, the development of a new cultural norm within this class setting could be a positive step toward addressing the issue of compression.

Windschiltl (1999) explained the benefits of a constructivist classroom (which could be the chess class in this case): "children who are immersed in the constructivist culture, in fact, tend to have a greater capacity … for persisting in problem-solving efforts" (p. 191). Persistence allows for more time involved in developing chess skill and "with practice, greater efficiency, and accuracy, strategies that were once effortful can become skills that are nearly automatic in some contexts" (Wyn-Dancy & Gillam, 1997, p. 35). Within a classroom setting, the problem solving skills of chess have the best opportunity to become habits of mind and transfer to other academic subjects.

Conclusion

Schools with high percentages of economically disadvantaged students have the dilemma of preparing those students for the high stakes standardized exams while at the same time trying to offer an enriched curriculum that can develop important problem solving skills. Unfortunately, evidence suggests that the high-stakes testing movement has negatively impacted the quality of education being offered to children from poverty. Standardized exams have been rhetorically promoted as an excellence in education movement. Proponents argue that by offering the same excellent educational standards to all students equity in education can also be achieved. However, standardization as a function of industrialization to improve profits through cost efficiency actually contradicts the value of equity. The impact of this contradiction has been the

development of two very different educational processes. The first is a streamlined curriculum for economically disadvantaged students where test preparation becomes the curriculum at the expense of long-term problem solving skills. The second is the enriched curriculum found in middle and upper socio-economic schools where an enriched curriculum continues to develop long-term skills.

Constructivist Learning Theory acknowledges the importance of social background (environment) to cognitive development, and may be the best framework for developing enrichment programs for economically disadvantaged students. Experts on constructivism have argued that placing problem solving within a specific social setting, students are provided the necessary support system to challenge their own cultural views. This support system has been argued to be fundamental for the development of problem solving.

Research from the review of literature revealed that the game of chess satisfies many of the problem solving needs for academic achievement, but it also can be taught in a manner consistent with constructivist theory. Research on chess and problem solving and research on constructivism have both come from the field of psychology. The learning theory is interested in how students develop cognitively and socially, and the chess has been used to evaluate cognition and metacognition. Over the last few decades educators have begun to study the connection between learning and chess. Several studies have been conducted to show the value of including chess as part of the school curriculum, but most of these studies have been conducted with children who do not share the same cultural background as children in South Texas. All of the studies to date have dealt primarily with middle to upper income class students. Most of the studies,

while being statistically significant, would not be practically significant for South Texas where a majority of students are identified as economically disadvantaged. Also, many of the studies had sample sizes below the minimums needed for statistical analysis.

Literature on the effects of chess to increase the thinking skills of economically disadvantaged students does not yet exist. However, related literature suggests that because chess is a spatial game, and provides an enriched learning context for developing higher order thinking skills, economically disadvantaged students could benefit from chess instruction. Research is needed to examine the relationship between chess instruction and the development of problem solving skills for economically disadvantaged students. Such a study would need to have a large enough sample to make statistical analysis relevant to others looking at chess as a possible enrichment program. Such a study would be significantly more valuable if the instruction was done in a socially supportive classroom setting where a culture of chess and a culture of problem solving could grow. Additionally, the use of formal classroom instruction would increase the ability of the teacher to teach for transference. The review of literature clearly pointed to the worthiness of a study of chess as a problem solving heuristic for economically disadvantaged students.

CHAPTER III

METHODOLOGY

This chapter is divided into five sections. The first section is concerned with the design of the research. The second section describes the participants of the study. The third section is a description of the instruments. The fourth section is an explanation of the procedures used to collect the data. The last section is an explanation of the procedures used for the analysis of data.

Research Questions

Based on the problem statement, purpose of this study, and review of literature the following research questions were devised for this study:

1. Is there a significant difference in verbal, quantitative, and nonverbal reasoning abilities, as measured with pre-tests and post-tests, for all students who received formal classroom chess instruction?
2. Is there a significant difference in verbal, quantitative, and nonverbal reasoning abilities, as measured with pre-tests and post-tests, for all students who did not receive formal classroom chess instruction?
3. Is there a significant difference in verbal, quantitative, and nonverbal reasoning abilities, as measured with pre-tests and post-tests, for economically disadvantaged students who received formal classroom chess instruction?
4. Is there a significant difference in verbal, quantitative, and nonverbal reasoning abilities, as measured with pre-tests and post-tests, for economically disadvantaged students who did not receive formal classroom chess instruction?

5. Is there a significant difference in verbal, quantitative, and nonverbal reasoning abilities, as measured with pre-tests and post-tests, for students not identified as economically disadvantaged who received formal classroom chess instruction?
6. Is there a significant difference in verbal, quantitative, and nonverbal reasoning abilities, as measured with pre-tests and post-tests, for students not identified as economically disadvantaged who did not receive formal classroom chess instruction?
7. Is there a significant difference between the pretest-posttest change of performance levels on the verbal reasoning abilities test for students identified as economically disadvantaged and students not identified as economically disadvantaged who received formal classroom chess instruction and students who did not receive chess instruction?
8. Is there a significant difference between the pretest-posttest change of performance levels on the quantitative reasoning abilities test for students identified as economically disadvantaged and students not identified as economically disadvantaged who received formal classroom chess instruction and students who did not receive chess instruction?
9. Is there a significant difference between the pretest-posttest change of performance levels on the quantitative reasoning abilities test for students identified as economically disadvantaged and students not identified as economically disadvantaged who received formal classroom chess instruction and students who did not receive chess instruction?

Research Hypotheses

The following hypotheses, based on the research questions, were formulated for the study:

1. There is a significant difference in verbal reasoning abilities, as measured with pre-tests and post-tests, for all students who received formal classroom chess instruction.
2. There is a significant difference in quantitative reasoning abilities, as measured with pre-tests and post-tests, for all students who received formal classroom chess instruction.
3. There is a significant difference in nonverbal reasoning abilities, as measured with pre-tests and post-tests, for all students who received formal classroom chess instruction.
4. There is a significant difference in verbal reasoning abilities, as measured with pre-tests and post-tests, for all students who did not receive formal classroom chess instruction.
5. There is a significant difference in quantitative reasoning abilities, as measured with pre-tests and post-tests, for all students who did not receive formal classroom chess instruction.
6. There is a significant difference in nonverbal reasoning abilities, as measured with pre-tests and post-tests, for all students who did not receive formal classroom chess instruction.

7. There is a significant difference in verbal reasoning abilities, as measured with pre-tests and post-tests, for economically disadvantaged students who received formal classroom chess instruction.
8. There is a significant difference in quantitative reasoning abilities, as measured with pre-tests and post-tests, for economically disadvantaged students who receive formal classroom chess instruction.
9. There is a significant difference in nonverbal reasoning abilities, as measured with pre-tests and post-tests, for economically disadvantaged students who received formal classroom chess instruction.
10. There is a significant difference in verbal reasoning abilities, as measured with pre-tests and post-tests, for economically disadvantaged students who did not receive formal classroom chess instruction.
11. There is a significant difference in quantitative reasoning abilities, as measured with pre-tests and post-tests, for economically disadvantaged students who did not receive formal classroom chess instruction.
12. There is a significant difference in nonverbal reasoning abilities, as measured with pre-tests and post-tests, for economically disadvantaged students who did not receive formal classroom chess instruction.
13. There is a significant difference in verbal reasoning abilities, as measured with pre-tests and post-tests, for students not identified as economically disadvantaged who received formal classroom chess instruction.

14. There is a significant difference in quantitative reasoning abilities, as measured with pre-tests and post-tests, for students not identified as economically disadvantaged who received formal classroom chess instruction.
15. There is a significant difference in nonverbal reasoning abilities, as measured with pre-tests and post-tests, for students not identified as economically disadvantaged who received formal classroom chess instruction.
16. There is a significant difference in verbal reasoning abilities, as measured with pre-tests and post-tests, for students not identified as economically disadvantaged who did not receive formal classroom chess instruction.
17. There is a significant difference in quantitative reasoning abilities, as measured with pre-tests and post-tests, for students not identified as economically disadvantaged who did not receive formal classroom chess instruction.
18. There is a significant difference in nonverbal reasoning abilities, as measured with pre-tests and post-tests, for students not identified as economically disadvantaged who did not receive formal classroom chess instruction.
19. There is a significant difference between the pretest-posttest change of performance levels on verbal reasoning abilities of all students identified as economically disadvantaged and all students not identified as economically disadvantaged.
20. There is a significant difference between the pretest-posttest change of performance levels on verbal reasoning abilities of students who received

formal classroom chess instruction and students who did not receive chess instruction.

21. There is a significant interaction between subject effects of chess instruction versus no chess instruction and students identified as economically disadvantaged versus students not identified as economically disadvantaged on the pretest-posttest change of performance levels on verbal reasoning abilities.

22. There is a significant difference between the pretest-posttest change of performance levels on quantitative reasoning abilities of all students identified as economically disadvantaged and all students not identified as economically disadvantaged.

23. There is a significant difference between the pretest-posttest change of performance levels on quantitative reasoning abilities of students who received formal classroom chess instruction and students who did not receive chess instruction.

24. There is a significant interaction between subject effects of chess instruction versus no chess instruction and students identified as economically disadvantaged versus students not identified as economically disadvantaged on the pretest-posttest change of performance levels on quantitative reasoning abilities.

25. There is a significant difference between the pretest-posttest change of performance levels on nonverbal reasoning abilities of all students identified

as economically disadvantaged and all students not identified as economically disadvantaged.

26. There is a significant difference between the pretest-posttest change of performance levels on nonverbal reasoning abilities of students who received formal classroom chess instruction and students who did not receive chess instruction.

27. There is a significant interaction between subject effects of chess instruction versus no chess instruction and students identified as economically disadvantaged versus students not identified as economically disadvantaged on the pretest-posttest change of performance levels on nonverbal reasoning abilities.

Research Design

The purpose of this study was to investigate the relationship of formal chess instruction and the problem-solving abilities of middle school students identified as economically disadvantaged. As revealed in the review of literature, problem solving is important for academic achievement for economically disadvantaged students. Subjects in this study were seventh and eighth grade students at a middle school in a large rural school district in South Texas. The middle school has offered Chess Class as an elective course since 1999.

Students who participated in this quasi-experimental study were identified as part of either the experimental group or part of the control group. Students identified as part of the experimental group were enrolled in one of the three Chess classes during the fall semester. Students identified as part of the control group were enrolled in Keyboarding

during the fall semester. The middle school schedule for electives is structured in a manner that those students enrolled in chess during the fall semester are enrolled in Keyboarding, Career Investigations, or Art during the spring semester. Students enrolled in Keyboarding, Career Investigations, or Art during the fall semester are enrolled in their choice of Chess, Keyboarding, Career Investigations, or Art in the spring semester. The fall semester was the best semester to conduct the study because of the predictability of the number of participants in both the experimental group and the control group. When schedules are changed at the beginning of the spring semester, not all of those students in the fall control group are enrolled in Chess, as they may select one of the other electives. Although there were three Chess classes in the spring, the enrollment would not be the same as the fall. The experimental group had 60 students, 41 of which were identified as economically disadvantaged. The control group had 93 students, 55 of which were identified as economically disadvantaged.

Campus counselors monitored both the experimental and control groups, tracking the movement of students in and out of both groups. Some students entered class too late for a pre-test, and took the post-test only. Other students transferred out of class after the pre-test and did not take a post-test. Additionally, within both the experimental and control groups, students were identified as "economically disadvantaged" or "not economically disadvantaged". The middle school counselors determined the economically disadvantaged status of the students using the "2001-2002 Fall School Report". Economically disadvantaged status and program evaluation test scores for students are private and were handled in compliance with the Family Educational Rights and Privacy Act (F.E.R.P.A.).

There were three chess classes that contributed to the experimental group and six keyboarding classes that contributed to the control group. Because there were three separate teachers for each of the experimental chess classes, the chess skill/knowledge, motivation, pedagogical skills, or a number of other teacher attributes could impact the level of instruction in each of the classes. To control for this teaching variable two computer programs designed for chess instruction, "First Lessons in Chess" and "Think Like A King", were used as the core curriculum for the experimental chess classes. A site license for the programs was purchased on behalf of the campus with grant money awarded to the researcher.

The "Think Like A King" program has two separate programs combined in the site license. The first is the basic instructional program called "First Lessons in Chess". In this program students interactively learn the basics of the game including the board, pieces, notation, and several basic tactics. Corresponding to each of the subdivisions is a series of puzzles with different timed levels that students may play to practice what they learn. The interactive nature of the program allows for immediate feedback, an effective pedagogical strategy to encourage persistence in learning. Students used the program in the computer lab two to three times a week, with the other days used for regular chess play against fellow classmates.

The second program was "Think Like A King", a much more detailed collection of digital and interactive chess books. The program has six books with multiple chapters and dozens of puzzles per chapter: Tactical Thinking (19 chapters), Checkmate Thinking (19 chapters), Endgame Thinking (16 chapters), Opening Thinking (20 chapters), More Checkmate Thinking (22 chapters), and More Tactical Thinking (21 chapters). In all, the

program offers over 1,700 puzzles. The difference between the “Think Like A King” books and “First Lessons in Chess” is that the puzzles in “Think Like A King” have a built in point system. Points are awarded with maximum points for solving a puzzle on the first try and then descending point values for each additional try. The program keeps track of points earned in each chapter and book for as many students as needed. The program is designed to allow the users to work on any book, any chapter, any puzzle, in any order. However, for the chess class, students were required to work through Tactical Thinking, Checkmate Thinking, and Endgame Thinking only, as that is about all that can be accomplished in a one semester class. Students could click on a 'points' window for an update of total points for that chapter, book, or total for all books combined at anytime during play.

At the end of each book, the program allows for a certificate of completion to be printed designated the completion of that chapter. Additionally, a color-coded system based on total points earned is part of the program. The color-coded system works much like the color belts in martial arts, with black belt being the highest rank. Awards and certificates can be customized for daily, weekly, monthly, individual, or team awards using the programs “Manager” program.

The “Think Like A King” collection of programs allowed the teachers to work as facilitators, the ideal role for a teacher in a constructivist modeled classroom. The programs also ensured that the quality of instruction was similar in each of the chess classes. Because the teachers felt more secure with the computerized curriculum, they reported that they looked forward to chess class and the opportunity to learn along with the students. Students were given the freedom to move through the program in any order

they felt comfortable with, and were encouraged to go back and replay some chapters after playing across the board. Students were graded based on effort to use the program as evidenced by progress made on the chapter puzzles. The teacher used the "Manager" program to pull up data on all student progress and could print reports for each student and the class as a whole.

There were four pre-tests and post-tests administered to both the experimental and control groups during the fall semester. For the first two tests, students took both the verbal, quantitative, and nonverbal batteries of the Cognitive Abilities Test (CogAT), developed by Robert Thorndike and Elizabeth Hagen. The CogAT was preferred over the reading and math scores from the Texas Assessment of Academic Skills (TAAS) because the review of literature indicated that the format of instruction for TAAS does not reflect significant learning experiences for economically disadvantaged students. Additionally, the nature of the test administration of the standardized tests makes them unreliable data.

Participants in the study also were administered the Naglieri Nonverbal Ability Test (NNAT), Level F. Since the focus of this study was the development of problem solving skills, the use of two nonverbal tests increased the legitimacy of the nonverbal component. The nonverbal battery of the CogAT uses geometric shapes to test for figure classification, analogies, and analysis. The NNAT requires similar skills, but it is based on pattern identification and problem solving, which has been determined by the review of literature to be of critical educational significance to economically disadvantaged students. The multi-colored format of the NNAT is an advantage over the black and white format of the CogAT nonverbal battery. The disadvantage of using the CogAT and

NNAT tests as post-tests, as well as pre-tests, is the possibility of test familiarity on behalf of the students, especially regarding questions and answers that students clearly remember from the pre-tests. However, familiarity would affect the post-test only if students were told the correct answers after the pre-test. Answers, or score results, of the tests were never discussed or given to the students. Results were made part of each student's file and were available to parents upon request. No requests were made.

Sample

The target population was economically disadvantaged students in South Texas. The accessible population was approximately 900 seventh and eighth grade students on a middle school campus. The campus and district of the accessible population was in Region 2 of South Texas. Region 2 is a 10 county area in South Texas with 43 school districts and a total enrollment of 107,892 students (71% ethnic minority), of which 66% have been identified as economically disadvantaged. The school district of the accessible population is in a rural town of approximately 20,000 residents with one high school, one middle school, two intermediate schools, and seven elementary schools. The enrollment for the district in 2000-2001 was 5,678 students (89% ethnic minority), of which 65% were identified as economically disadvantaged. The enrollment at the middle school in 2000-2001 was 870 students (88% ethnic minority), of which 68% have been identified as economically disadvantaged (T.E.A., 2001).

Since the students have open enrollment for electives, as well as counselors assigning students to electives based on scheduling demands and class size limits, the sample for the study was non-random and self-selected. There were 60 students participating in the experimental Chess group and 93 students participating in the control

group enrolled in Keyboarding. The 40 economically disadvantaged students in the experimental group out of the 60 were 67%, consistent with the campus average. The 55 economically disadvantaged students in the control group out of the 93 was 60%, is slightly lower than the campus average, but still very similar.

Description of the Instruments

There were two different instruments used as pre-tests and post-tests for this study. First, the Cognitive Abilities Test, Form 4, Multilevel Edition (CogAT) was used to evaluate verbal, quantitative, and nonverbal abilities. Second, the Naglieri Nonverbal Ability Test (NNAT) was used to evaluate nonverbal reasoning. The following sections are descriptions of the NNAT and the CogAT.

Naglieri Nonverbal Ability Test

The NNAT was used to measure nonverbal reasoning through problem solving and pattern identification. The NNAT was developed as a "brief, culture-fair, nonverbal measure of school ability" (Harcourt Brace Educational Measurement, 1997, p. 5). The NNAT uses figural matrices to assess thinking skills that students must use to read, write, or speak. The NNAT is a revision of the 1985 Matrix Analogies Test (MAT). The testing format of figural matrices has nearly 50 years of research to support it. The Multilevel Norms Booklet of the NNAT states that "the geometric shapes composing NNAT items are universal" ensuring "fairness across gender, race, and ethnicity" (Harcourt Brace, 1997, p. 5). Even though "factual knowledge, vocabulary, mathematics, and reading skills are not prerequisites", the pattern identification skills necessary for success in such academic areas are tested by the figural matrices (Harcourt Brace, 1997, p. 5). This is because the matrices require "a student to see the patterns formed by

shapes organized into colorful designs and then to choose a response that completes the pattern" (Harcourt Brace, 1997, p. 5). The NNAT was used for this study because it reflects the basic thinking skills and processes required for reading, writing, and speaking as discussed in the review of literature.

The NNAT is structured and organized into different difficulty levels for different grade levels from Kindergarten to twelfth grade. The levels are labeled A for Kindergarten, B for first grade, C for second grade, D for third and fourth grade, E for fifth and sixth grade, F for seventh, eighth, and ninth grade, and G for tenth, eleventh, and twelfth grade. Level F was used for this study. Level F, as with all of the levels, has 38 test items selected for appropriateness at that age level. Problems are clustered under four categories: pattern completion, reasoning by analogy, serial reasoning, and spatial visualization (Harcourt Brace, 1997, p. 6). Based on the company's research, the NNAT introduces various clusters at particular levels, and eliminates others at higher levels. For example, serial reasoning is not used until level B and spatial visualization is not introduced until level C. On the other hand, simple pattern completion is no longer included in levels F and G. Pattern identification is still essential at levels F and G, but as an inclusive skill for reasoning by analogy, serial reasoning, and spatial visualization.

For the level F test used in this study, three of the four clusters of figural matrices were used: reasoning by analogy, serial reasoning, and spatial visualization. Reasoning by analogy items "require the student to recognize a logical relationship between several geometric shapes…. To determine the correct response, the student must see how an object changes as it appears in the squares across the rows and down the columns of the design" (Harcourt Brace, 1997, p. 7). Students had to choose one of five possible answers

for reasoning by analogy items. Serial reasoning items "incorporate a series of shapes that change across the rows horizontally and the columns vertically…as each shape appears in the squares down the matrix, it also appears one position to the right, creating a series of designs that change over the matrix" (Harcourt Brace, 1997, p. 7). Students chose one of five possible answers for serial reasoning items. Spatial visualization items "require the student to recognize how two or more designs would look if combined…the child has to determine that the answer is obtained by adding the boxes above or to the left of the empty box" (Harcourt Brace, 1997, p. 7). Students chose one of five possible answers for spatial visualization items. Spatial visualization is considered the most complex of the three clusters used in level F.

Based on decades of research, the NNAT is considered appropriate for measuring general ability and as a "predictor of scholastic achievement" for students "from diverse cultural and language backgrounds." More importantly, for this study, the NNAT was considered appropriate for "fair assessment of socially or economically disadvantaged students" (Harcourt Brace, 1997, p. 8).

The raw score on the NNAT, the number of items out of 38 that were answered correctly, were used to determine a Nonverbal Ability Index (NAI), which is a normalized standard score with a mean of 100 and a standard deviation of 15 (Harcourt Brace, 1997, p. 13). The NAI's are listed in the NNAT "Multilevel Norms Booklet" by chronological ages with three-month intervals. These NAI's could then be converted to percentile ranks and stanines. However, the percentile ranks create problems at the far ends (the 90 to 95 percentile ranks) where there are fewer scores because the smaller numerical differences actually have greater statistical significance than near the middle

(the 50 percentile rank) where there are more scores and lesser statistical significance between percentile ranks. The NNAT provides a table for converting NAI's to percentile ranks. A table is also provided to convert percentile ranks to stanines, which are normalized standard scores that range from 1 to 9 with equal value in the ability difference symbolized by each of the stanines. These age-based stanines "indicate students' levels of ability compared with other students of the same chronological age" and "possess greater stability, and they reduce the likelihood of misinterpretations of small differences in test scores" (Harcourt Brace, 1997, p. 14).

The final system for interpreting the NNAT results is the scaled score system. According to the publishers of the NNAT, the scaled score system "links together all levels of the test, yielding a continuous scale that makes it possible to compare the performance of students taking different levels of the test," therefore no longer needing the "Nonverbal Ability Index…or the grade-based percentile ranks, [or] stanine…."(Harcourt Brace, 1997, p. 13). The publishers write that the scaled score system is the most suitable of the scoring systems "for studying change in performance over time" (Harcourt Brace, 1997, p. 13). The scaled scores were the NNAT scores used for evaluating the performance of the students in this study.

To provide norms for the test, the developers of the NNAT administered the test to 90,000 students from kindergarten through twelfth grade. Statistics were derived from the United States Department of Education regarding population percentages of the four major geographical regions (Northeast, Midwest, South, West), the five levels of socio-economic status (low, low-middle, middle, high-middle, high), three levels of urbanicity (urban, suburban, rural), ethnicity (African American, Hispanic, White, Other), and

nonpublic schools (Catholic, private). The percentage of students taking the NNAT for the purpose of standardization was matched as closely as possible with the total U.S. enrollment percentage for each category (Harcourt Brace, 1997, p. 11). The demographics of the students in the sample of this chess study were represented fairly in the NNAT standardization sample.

Cognitive Abilities Test

The CogAT was used to measure developed verbal, quantitative, and nonverbal abilities. These abilities include students' in and out of school experiences that "enable him or her to learn new tasks or solve problems when instruction is absent or incomplete" (Thorndike and Hagen, 1986, p. 5). The CogAT was based on 35 years of research at the time of publication in 1986, and it is still used in numerous school districts for program evaluation or program qualification. The Cognitive Abilities Test, Form 4, Multilevel Edition is the revised edition of earlier Cognitive Abilities Test editions, and of the earliest edition, the Lorge-Thorndike Intelligence Tests (Thorndike and Hagen, 1986, p. 5). The CogAT has been designed to address the various learning styles for solving problems and processing information. The CogAT recognizes the "differences in both level and pattern of general cognitive skills" by testing students in three separate batteries: a verbal battery, a quantitative battery, and a nonverbal battery (Thorndike and Hagen, 1986, p. 5). This study used all three batteries of the CogAT.

The verbal, quantitative, and nonverbal batteries of the CogAT are structured and organized in eight levels of difficulty ranging from A to H. The multilevel edition of the CogAT that was used in this study covers the range of third grade to twelfth grade. The eight levels can be used to determine if a student is slow, typical, or rapid in the tested

abilities for a particular grade level. The format of the tests is multilevel. Items are placed in a series based on the level of difficulty, identified as level A, B, C, D, E, F, G, or H. The test administrators in a given situation would choose the starting level for students based on the purpose of the examination. The seventh and eighth grade students in the Chess Class started at level F.

The verbal battery consisted of three tests: verbal classification, sentence completion, and verbal analogies. The items on the verbal classification test "require the individual to abstract the common element among three of four verbal stimuli and then to select the word that goes with them" (Thorndike and Hagen, 1986, p. 6). The items on the sentence completion test "require that an individual comprehend the thought or idea expressed in a sentence and then select the word or phrase that best completes the sentence" (Thorndike and Hagen, 1986, p. 6). The items on the verbal analogy test "require the individual to discover the relationship between a pair of words and then, given a third word which is the first word of a second pair, to complete the analogy" (Thorndike and Hagen, 1986, p. 6). Each question in the three tests of the verbal battery is five-choice multiple response. Combined, the three tests of the verbal battery total to 75 items with 30 minutes of time allotted for the completion of the entire battery. A raw score for the verbal battery is determined by the number of items answered correctly out of the 75 combined items from all three tests in the battery. As with the NNAT, the raw score was converted to a scaled score using the Cognitive Abilities Test "Examiner's Manual".

The quantitative battery consists of three tests: quantitative relations, number series, and equation building. The quantitative relations test "requires the individual to

make judgments about the relative sizes or amounts of quantitative materials" (Thorndike and Hagen, 1986, p. 6). The number series test "requires the individual to discover the rule or principle that underlies a series of numbers and then to choose the number that comes next in the series" (Thorndike and Hagen, 1986, p. 6). The equation-building test "presents numbers and mathematical signs that the individual must arrange and combine to produce an equation that will give one of the answer choices" (Thorndike and Hagen, 1986, p. 6). The number series and equation building tests are five-choice multiple response, but the quantitative relations test in a three-choice multiple response. Combined, the three tests of the quantitative battery total to 60 items with 30 minutes of time allotted for the completion of the entire battery. A raw score for the verbal battery is determined by the number of items answered correctly out of the 60 combined items from all three tests in the battery. The raw score was converted to a scaled score using the Cognitive Abilities Test "Examiner's Manual".

The Nonverbal Battery includes three tests: Figure Classification, Figure Analogies, and Figure Analysis. The items on the Figure Classification test "requires the individual to abstract the common element from three or four geometric figures and then to select the figure that goes with them" (Thorndike and Hagen, 1986, p. 6). This is similar to the NNAT. The items on the Figure Analogies test "requires the individual to discover the relationship between a pair of figures and then, given a third figure which is the first figure of a second pair, to select the figure that completes the analogy" (Thorndike and Hagen, 1986, p. 6). The items on the Figure Analysis test "requires the examinee to reconstruct a design from a sequence of cues" (Thorndike and Hagen, 1986, p. 6). The authors of the "Examiner's Manual" write that the Nonverbal Battery does not

correlate to academic success as much as the Qualitative and Verbal Batteries. However, Thorndike and Hagen write that the Nonverbal Battery "is more useful…for obtaining an accurate assessment of the cognitive development of students who have difficulty with reading or for whom English is not the first language" (Thorndike and Hagen, 1986, pp. 6-7). Combined, the three tests of the Nonverbal Battery total to 65 items with 30 minutes of time allotted for the completion of the entire battery. A raw score for the Nonverbal Battery is determined by the number of items answered correctly out of the 65 combined items from all three tests in the battery. The raw score was converted to a scaled score using the Cognitive Abilities Test "Examiner's Manual".

The authors of the CogAT "Examiner's Manual" present the various score reports in a manner that emphasizes testing for the purpose of student placement in special programs, or as an ongoing analysis of ability development. Nevertheless, the rationale and theory behind the test clearly support the use of the CogAT as a tool for analyzing "both level and pattern of these developed abilities" with the intent of providing varied instructional methods and materials to the varied learning styles of students. Unlike the NNAT, the authors of the CogAT do not make recommendations about which score report should be used when a researcher/educator is interested in evaluating changes in performance over a period of time. The authors of the NNAT argue that scaled scores are the best format to use to measure changes in performance. Since the CogAT also provides a table for calculating scale scores (Universal Scale Score), this study measured changes in performance on the Verbal, Quantitative, and Nonverbal batteries using the Universal Scale Scores for each battery.

For the purpose of CogAT standardization and norms, approximately 167,500 students were tested, averaging about 13,000 students per grade level. The standardization sample was selected to represent "geographic region, school district size, and socio-economic level" (Thorndike and Hagen, 1986, 4). To ensure item fairness, a national tryout of the CogAT's three batteries over sampled African American students (29%) and Hispanic students (24%), and used the results as part of the item selection (Thorndike and Hagen, 1986, p. 4). This is relevant to this study of the impact of chess on South Texas students since a majority of the students are Hispanic. Test reliability estimates (coefficients of equivalence) were .90 for the verbal battery and .91 for the quantitative battery (Thorndike and Hagen, 1986, p. 3).

Data Collection

The testing of students enrolled in the chess classes has been part of program evaluation since 1999. In the past, counselors have administered self-esteem inventories and the Matrix Analogies Test (MAT) to determine the effectiveness of chess as an elective. Each year, the evaluations have been used to make adjustments in the program delivery. With the data from the previous years available, the researcher designed a proposal for the 2001-2002 program evaluation. A letter requesting permission to use the data from the program evaluation was submitted to the campus principal, which in turn was forwarded to the district superintendent. The letter requested permission to use the data for partial fulfillment of a doctoral dissertation, but that student confidentiality would be maintained in accordance with federal law. The study was not emphasized openly in front of the students to avoid intentional harm, or assistance, to the study. As

with the previous years, the pre and posttests were part of the campus services offered to the students.

The pre-tests of the CogAT Verbal, Quantitative, and Nonverbal Batteries, and the NNAT, were administered during the fourth week of school of the Spring semester. The campus counselor administered the pre-tests and post-tests. The classroom chess instructor served as a facilitator during the testing.

Students reported for the first day of school on Thursday, January 10th. Because the first few days of the semester are usually hectic with students moving in and out of classes, testing began on Tuesday, February 12th. Students in the experimental group were pulled from class on Tuesday, February 12th between 8:00 a.m. and 10:00 a.m. to test in the Student Activity Center. Students completed all four of the tests. Students in the control group were divided into two groups to make the testing more manageable. The first half of the control group tested in the Student Activity Center on Wednesday, February 13th between 8:00 a.m. and 10:00 a.m. The second half of the control group tested on Thursday, February 14th, also between 8:00 a.m. and 10:00 a.m.

There were three test days for the post-tests. Following the same format as the pre-tests, the experimental group tested in the Student Activity Center Tuesday, May 14th. Students in the control group tested in the Student Activity Center on Wednesday, May 15th and Thursday May 16th. The total number of weeks between the pre-tests and post-tests was thirteen weeks. One week during this time was Spring Break, leaving twelve weeks of formal classroom instruction between the pre-tests and post-tests. Students had four weeks of instruction prior to the beginning of the pre-tests. The first week of class dealt mostly with students moving in and out due to the need for a schedule change. The

other three weeks dealt primarily with basic instruction (the board, the pieces, how to move, check and checkmate). Instruction on problem solving and opportunities to identify patterns usually begins after at least three to four weeks of basic instruction and practice.

In order not to bias the counselor administering the tests, or teacher expectations of individual students, the data collected from the pre-tests and post-tests were not scored (raw score) and converted to scaled scores until the completion of the study.

The counselor kept a master record of all students in both the experimental and control groups. The counselor decided that students who came in after the pre-test dates would not be tested, but if still enrolled at the end of the semester those students would participate in the post-test. This decision meant all students in the class at the time of pre-test or post-test were tested, regardless if certain students would have only a set of pre or post tests at the end of the semester.

Data Analysis

Because of the movement of students in and out of the classes used for the experimental and control groups, only students with both pre-tests and posttests were reported. The counselor collected 60 sets of tests for all three CogAT exams and the NNAT. Within the experimental group, the counselor identified 41 as economically disadvantaged and 19 as not economically disadvantaged. The control group had considerably more student mobility, resulting in different numbers of complete sets for the various CogAT exams and NNAT. The CogAT Verbal Battery had 77 complete sets, 47 of which were identified as economically disadvantaged and 30 as not economically disadvantaged. The CogAT Quantitative Battery had 77 complete sets, 47 of which were

identified as economically disadvantaged and 30 as not economically disadvantaged. The CogAT Nonverbal Battery had 88 complete sets, 53 of which were identified as economically disadvantaged and 35 as not economically disadvantaged. The NNAT had 93 complete sets, 55 of which were identified as economically disadvantaged and 38 as not economically disadvantaged. Raw scores from the pre-test and post-test for both the experimental and control groups were converted to scale scores. The biographical data and the pre-test and post-test scale score data were input in the Statistical Package for Social Sciences (SPSS) for Windows, Version 10.0.

Descriptive statistics based on student participants' biographical data were obtained for both the experimental and control groups. Primary interest was given to the number of students identified as economically disadvantaged or not economically disadvantaged in both the experimental and control groups. A paired t-test was used to test for significance beyond the .05 levels to measure the level of significance of change in performance between the pre-test and the post-test. A two-way ANOVA was used to measure for statistically significant interaction between subject effects of economically disadvantaged students versus not economically disadvantaged and the experimental chess instruction group versus the control no chess instruction group.

The paired t-test was used to compare the pre-test and post-test means of the CogAT Verbal Battery scale scores for the following groups: (a) all experimental group participants, (b) all control group participants, (c) economically disadvantaged experimental group participants, (d) not economically disadvantaged experimental group participants, (e) economically disadvantaged control group participants, and (f) not economically disadvantaged control group participants.

The paired t-test was used to compare the pre-test and post-test means of the CogAT Quantitative Battery scale scores for the following groups: (a) all experimental group participants, (b) all control group participants, (c) economically disadvantaged experimental group participants, (d) not economically disadvantaged experimental group participants, (e) economically disadvantaged control group participants, and (f) not economically disadvantaged control group participants.

The paired t-test was used to compare the pre-test and post-test means of the CogAT Nonverbal Battery scale scores for the following groups: (a) all experimental group participants, (b) all control group participants, (c) economically disadvantaged experimental group participants, (d) not economically disadvantaged experimental group participants, (e) economically disadvantaged control group participants, and (f) not economically disadvantaged control group participants.

The paired t-test was used to compare the pre-test and post-test means of the NNAT scale scores for changes in performance for the following groups: (a) all experimental group participants, (b) all control group participants, (c) economically disadvantaged experimental group participants, (d) not economically disadvantaged experimental group participants, (e) economically disadvantaged control group participants, and (f) not economically disadvantaged control group participants.

The two-way ANOVA was used in this study to evaluate the difference between: (a) the pretest-posttest change of performance levels on verbal reasoning abilities for students who received formal classroom chess instruction and students who did not receive chess instruction, (b) the pretest-posttest change of performance levels on verbal reasoning abilities for all students identified as economically disadvantaged and all

students not identified as economically disadvantaged, (c) the pretest-posttest change of performance levels on quantitative reasoning abilities for students who received formal classroom chess instruction and students who did not receive chess instruction, (d) the pretest-posttest change of performance levels on quantitative reasoning abilities for all students identified as economically disadvantaged and all students not identified as economically disadvantaged, (e) the pretest-posttest change of performance levels on nonverbal reasoning abilities for students who received formal classroom chess instruction and students who did not receive chess instruction, and (f) the pretest-posttest change of performance levels on nonverbal reasoning abilities for all students identified as economically disadvantaged and all students not identified as economically disadvantaged.

The two-way ANOVA was used in this study to evaluate the interaction between subject effects of: (a) chess instruction versus no chess instruction and students identified as economically disadvantaged versus students not identified as economically disadvantaged on the pretest-posttest change of performance levels on verbal reasoning abilities, (b) chess instruction versus no chess instruction and students identified as economically disadvantaged versus students not identified as economically disadvantaged on the pretest-posttest change of performance levels on quantitative reasoning abilities, and (c) chess instruction versus no chess instruction and students identified as economically disadvantaged versus students not identified as economically disadvantaged on the pretest-posttest change of performance levels on nonverbal reasoning abilities.

Summary

The purpose of this study was to investigate the relationship between formal chess instruction for economically disadvantaged middle school students and their performance on verbal, quantitative, and nonverbal reasoning tests. The study was a quasi-experimental, single factor, repeated-measure design, utilizing chess classes at a South Texas middle school campus for an experimental group, an elective course at the same campus as the control group. The demographics of the available population were consistent with the target population, identified as economically disadvantaged students in South Texas. The students sampled were administered pre-tests and post-tests as the basis for an investigation into changes in performance on reasoning abilities and as predictors of academic achievement. The independent variable was the implementation of chess instruction for one academic semester for the experimental group, and the lack of chess instruction for the control group. The dependent variable was the scale scores from verbal, quantitative, and nonverbal reasoning tests. The Cognitive Abilities Test (CogAT), Verbal Battery, Quantitative Battery, and Nonverbal Battery were used. The Naglieri Nonverbal Abilities Test (NNAT) was also used for the evaluation of nonverbal reasoning.

The raw scores of the CogAT and NNAT tests were converted to scale scores for the purpose of analysis using the SPSS for Windows, Version 10.0. A paired t-test was used to investigate changes in performance from the pre-test to the post-test for all students in both the experimental and control groups. A paired t-test was used to investigate changes in performance from the pre-test to the post-test for economically disadvantaged and non-economically disadvantaged students in the experimental group,

and again in the control group. The analysis of variance (ANOVA) was used to determine the significance of difference of the means within the groups and between the groups.

CHAPTER IV

PRESENTATION AND ANALYSIS OF DATA

The purpose of the study was to examine the relationship between chess instruction and verbal, quantitative, and nonverbal reasoning abilities of economically disadvantaged students. Data was collected for the experimental chess instruction group and the control group not receiving chess instruction. Data was examined for economically disadvantaged students and students not identified as economically disadvantaged in both the experimental and control groups. This chapter presents an analysis of the data used to examine the relationship between chess instruction and the reasoning abilities of both socioeconomic identifications and study groups. Each research question, and related hypotheses, is addressed separately using data collected from the pretests and posttests.

Results

Research Question # 1

Was there a significant difference in verbal, quantitative, and nonverbal reasoning abilities, as measured with pre-tests and post-tests, for all students who received formal classroom chess instruction?

Null Hypothesis 1

There is no significant difference in verbal reasoning abilities, as measured with pre-tests and post-tests, for all students who received formal classroom chess instruction.

Table 1 presents the means and standard deviations for the Verbal Battery of the CogAT of the students in the chess instruction group. There were 60 scores in the pretest distribution, with a low score of 207 and a high score of 285. The mean of the

distribution was 247.87 and the standard deviation was 16.73. There were 60 scores in the posttest distribution, with a low score of 223 and a high score of 289. The mean of the distribution was higher than the pretest at 250.68 and the standard deviation was similar at 16.3.

Table 1

Descriptives for Verbal Results: Chess Instruction

	N	Minimum	Maximum	Mean	Std. Deviation
Verbal Pre	60	207	285	247.87	16.73
Verbal Post	60	223	289	250.68	16.3

A paired-samples t test was conducted to evaluate whether students in the chess instruction group significantly improved in verbal reasoning abilities. The results indicated that the mean concern for the verbal reasoning posttest (M = 250.68, SD = 16.3) was significantly greater than the mean concern for the verbal reasoning pretest (M = 247.87, SD = 16.73), t (59) = -2.59, p = .012. The standardized effect size index, eta squared, was .122, a moderate value. The null hypothesis 1 was rejected. Students in the experimental chess classes improved significantly from the pretest to the posttest on the Verbal Reasoning Batteries of the CogAT.

Null Hypothesis 2

There is no significant difference in quantitative reasoning abilities, as measured with pre-tests and post-tests, for all students who received formal classroom chess instruction.

Table 2 presents the means and standard deviations for the Quantitative Battery of the CogAT of the students in the chess instruction group. There were 60 scores in the pretest distribution, with a low score of 214 and a high score of 282. The mean of the

distribution was 251.5 and the standard deviation was 16.18. There were 60 scores in the posttest distribution, with a low score of 225 and a high score of 291. The mean of the distribution was higher than the pretest at 252.68 and the standard deviation was similar at 17.25.

Table 2

Descriptives for Quantitative Results: Chess Instruction

	N	Min	Max	M	SD
Quant. Pre	60	214	282	251.50	16.18
Quant. Post	60	225	291	252.68	17.25

A paired-samples t test was conducted to evaluate whether students in the chess instruction group significantly improved in quantitative reasoning abilities. The results indicated that the mean concern for the quantitative reasoning posttest (M = 252.68, SD = 17.25) was not significantly greater than the mean concern for the quantitative reasoning pretest (M = 251.5, SD = 16.18), t (59) = -.66, p = .51. The standardized effect size index, eta squared, was .007, a small value. The null hypothesis 2 was not rejected. Students in the experimental chess classes did not improve significantly from the pretest to the posttest on the Quantitative Reasoning Batteries of the CogAT.

Null Hypothesis 3

There is no significant difference in nonverbal reasoning abilities, as measured with pre-tests and post-tests, for all students who received formal classroom chess instruction.

Table 3 presents the means and standard deviations for the Nonverbal Battery of the CogAT and the Naglieri Nonverbal Abilities Test of the students in the chess instruction group. There were 60 scores in the CogAT pretest distribution, with a low

score of 201 and a high score of 278. The mean of the distribution was 238.58 and the standard deviation was 17.23. There were 60 scores in the CogAT posttest distribution, with a low score of 208 and a high score of 292. The mean of the distribution was higher than the pretest at 244.98 and the standard deviation was similar at 18.48.

There were 60 scores in the NNAT pretest distribution, with a low score of 564 and a high score of 709. The mean of the distribution was 637.27 and the standard deviation was 31.48. There were 60 scores in the NNAT posttest distribution, with a low score of 554 and a high score of 717. The mean of the distribution was higher than the pretest at 694.45 and the standard deviation was similar at 36.56.

Table 3

Descriptives for Nonverbal Results: Chess Instruction

	N	Min	Max	M	SD
CogAT Pre	60	201	278	238.58	17.23
CogAT Post	60	208	292	244.98	18.48
NNAT Pre	60	564	709	637.27	31.48
NNAT Post	60	554	717	649.45	36.56

A paired-samples t test was conducted to evaluate whether students in the chess instruction group significantly improved in nonverbal reasoning abilities. The results indicated that the mean concern for the CogAT nonverbal reasoning posttest (M = 244.98, SD = 18.48) was significantly greater than the mean concern for the CogAT nonverbal reasoning pretest (M = 238.58, SD = 17.23), t (59) = -3.74, p = .000. The standardized effect size index, eta squared, was .192, a large value. The null hypothesis 3 was rejected. Students in the experimental chess classes improved significantly from pretest to posttest on the Nonverbal Reasoning Batteries of the CogAT.

A paired-samples t test was conducted also to evaluate whether students in the chess instruction group significantly improved in nonverbal reasoning abilities as measured by the Naglieri Nonverbal Abilities Test. The results indicated that the mean concern for the NNAT posttest (M = 649.45, SD = 36.56) was significantly greater than the mean concern for the NNAT pretest (M = 637.27, SD = 31.48), t (59) = -3.31, p = .002. The standardized effect size index, eta squared, was .157, a large value. The null hypothesis 3 was rejected. Students in the experimental chess classes improved significantly from pretest to posttest on the Naglieri Nonverbal Abilities Test.

Research Question # 2

Was there a significant difference in verbal, quantitative, and nonverbal reasoning abilities, as measured with pre-tests and post-tests, for all students who did not receive formal classroom chess instruction?

Null Hypothesis 4

There is no significant difference in verbal reasoning abilities, as measured with pre-tests and post-tests, for all students who did not receive formal classroom chess instruction.

Table 4 presents the means and standard deviations for the Verbal Battery of the CogAT of the students in the group that did not receive chess instruction. There were 95 scores in the pretest distribution, with a low score of 219 and a high score of 290. The mean of the distribution was 253.44 and the standard deviation was 14.14. There were 91 scores in the posttest distribution, with a low score of 211 and a high score of 292. The mean of the distribution was higher than the pretest at 253.48 and the standard deviation was similar at 16.53

Table 4

Descriptives for Verbal Results: No Chess

	N	Min	Max	M	SD
Verbal Pre	95	219	290	253.44	14.14
Verbal Post	91	211	292	253.48	16.53

A paired-samples t test was conducted to evaluate whether students who did not receive chess instruction significantly improved in verbal reasoning abilities. The results indicated that the mean concern for the verbal reasoning posttest (M = 253.79, SD = 17.28) was not significantly greater than the mean concern for the verbal reasoning pretest (M = 254.56, SD = 14.61), t (76) = .59, p = .555. The standardized effect size index, eta squared, was .005, a small value. The null hypothesis 4 was not rejected. Students in the no chess control classes did not improve significantly from pretest to posttest on the Verbal Reasoning Batteries of the CogAT.

Null Hypothesis 5

There is no significant difference in quantitative reasoning abilities, as measured with pre-tests and post-tests, for all students who did not receive formal classroom chess instruction.

Table 5 presents the means and standard deviations for the Quantitative Battery of the CogAT of the students who did not receive chess instruction. There were 98 scores in the pretest distribution, with a low score of 220 and a high score of 301. The mean of the distribution was 257.92 and the standard deviation was 15.91. There were 86 scores in the posttest distribution, with a low score of 223 and a high score of 313. The mean of

the distribution was higher than the pretest at 256.36 and the standard deviation was similar at 18.59.

Table 5

Descriptives for Quantitative Results: No Chess

	N	Min	Max	M	SD
Quant Pre	98	220	301	257.92	15.91
Quant Post	86	223	313	256.36	18.59

A paired-samples t test was conducted to evaluate whether students who did not receive chess instruction significantly improved in quantitative reasoning abilities. The results indicated that the mean concern for the verbal reasoning posttest (M = 256.82, SD = 18.88) was not significantly greater than the mean concern for the quantitative reasoning pretest (M = 257.9, SD = 15.79), t (76) = .8, p = .426. The standardized effect size index, eta squared, was .008, a small value. The null hypothesis 5 was not rejected. Students in the no chess control classes did not improve significantly from pretest to posttest on the Quantitative Reasoning Batteries of the CogAT.

Null Hypothesis 6

There is no significant difference in nonverbal reasoning abilities, as measured with pre-tests and post-tests, for all students who did not receive formal classroom chess instruction.

Table 6 presents the means and standard deviations for the Nonverbal Battery of the CogAT and the Naglieri Nonverbal Abilities Test of the students in the chess instruction group. There were 103 scores in the CogAT pretest distribution, with a low score of 194 and a high score of 298. The mean of the distribution was 244.08 and the

standard deviation was 19.37. There were 93 scores in the CogAT posttest distribution, with a low score of 205 and a high score of 298. The mean of the distribution was higher than the pretest at 245.36 and the standard deviation was similar at 21.2.

There were 105 scores in the NNAT pretest distribution, with a low score of 554 and a high score of 717. The mean of the distribution was 643.74 and the standard deviation was 32.70. There were 100 scores in the NNAT posttest distribution, with a low score of 572 and a high score of 755. The mean of the distribution was higher than the pretest at 648.15 and the standard deviation was similar at 35.66.

Table 6

Descriptives for Nonverbal Results: No Chess

	N	Min	Max	M	SD
CogAT Pre	103	194	298	244.08	19.37
CogAT Post	93	205	298	245.36	21.20
NNAT Pre	105	554	717	643.74	32.70
NNAT Post	100	572	755	648.15	35.66

A paired-samples t test was conducted to evaluate whether students who did not receive chess instruction significantly improved in nonverbal reasoning abilities. The results indicated that the mean concern for the CogAT nonverbal reasoning posttest (M = 246.15, SD = 21.51) was not significantly greater than the mean concern for the CogAT nonverbal reasoning pretest (M = 245.48, SD = 19.77), t (87) = -.5, p = .617. The standardized effect size index, eta squared, was .003, a small value. The null hypothesis 6 was not rejected. Students in the no chess control classes did not improve significantly from pretest to posttest on the Nonverbal Reasoning Batteries of the CogAT.

A paired-samples t test was also conducted to evaluate whether students who did not receive chess instruction significantly improved in nonverbal reasoning abilities as measured by the Naglieri Nonverbal Abilities Test. The results indicated that the mean concern for the NNAT posttest (M = 649.14, SD = 35.44) was not significantly greater than the mean concern for the NNAT pretest (M = 646.14, SD = 32.05), t (92) = -1.45, p = .151. The standardized effect size index, eta squared, was .022, a small value. The null hypothesis 6 was not rejected. Students in the no chess control classes did not improve significantly from pretest to posttest on the Naglieri Nonverbal Abilities Test.

Research Question # 3

Was there a significant difference in verbal, quantitative, and nonverbal reasoning abilities, as measured with pre-tests and post-tests, for economically disadvantaged students who received formal classroom chess instruction?

Null Hypothesis 7

There is no significant difference in verbal reasoning abilities, as measured with pre-tests and post-tests, for economically disadvantaged students who received formal classroom chess instruction.

Table 7 presents the means and standard deviations for the Verbal Battery of the CogAT of the students identified as economically disadvantaged in the chess instruction group. There were 41 scores in the pretest distribution, with a low score of 207 and a high score of 279. The mean of the distribution was 247.29 and the standard deviation was 16.26. There were 41 scores in the posttest distribution, with a low score of 227 and a high score of 289. The mean of the distribution was higher than the pretest at 249.12 and the standard deviation was similar at 15.42.

Table 7

Descriptives for Verbal Results: Economically Disadvantaged Chess Instruction

	N	Min	Max	M	SD
Verbal Pre	41	207	279	247.29	16.26
Verbal Post	41	227	289	249.12	15.42

A paired-samples t test was conducted to evaluate whether economically disadvantaged students in the experimental chess instruction group significantly improved in verbal reasoning abilities. The results indicated that the mean concern for the verbal reasoning posttest (M = 249.12, SD = 15.42) was not significantly greater than the mean concern for the verbal reasoning pretest (M = 247.29, SD = 16.26), t (40) = -1.34, p = .187. The standardized effect size index, eta squared, was .043, a small value. The null hypothesis 7 was not rejected. Economically disadvantaged students in the experimental chess classes did not improve significantly from pretest to posttest on the Verbal Reasoning Batteries of the CogAT.

Null Hypothesis 8

There is no significant difference in quantitative reasoning abilities, as measured with pre-tests and post-tests, for economically disadvantaged students who receive formal classroom chess instruction.

Table 8 presents the means and standard deviations for the Quantitative Battery of the CogAT of the students identified as economically disadvantaged in the chess instruction group. There were 60 scores in the pretest distribution, with a low score of 214 and a high score of 282. The mean of the distribution was 251.5 and the standard deviation was 16.18. There were 60 scores in the posttest distribution, with a low score of

225 and a high score of 291. The mean of the distribution was higher than the pretest at 252.68 and the standard deviation was similar at 17.25.

Table 8

Descriptives for Quantitative Results: Economically Disadvantaged Chess Instruction

	N	Min	Max	M	SD
Quant Pre	41	214.0	280.0	250.02	16.74
Quant Post	41	225.0	286.0	250.63	17.09

A paired-samples t test was conducted to evaluate whether economically disadvantaged students in the experimental chess instruction group significantly improved in quantitative reasoning abilities. The results indicated that the mean concern for the quantitative reasoning posttest (M = 250.63, SD = 17.09) was not significantly greater than the mean concern for the quantitative reasoning pretest (M = 250.02, SD = 16.74), t (40) = -.27, p = .785. The standardized effect size index, eta squared, was .002, a small value. The null hypothesis 8 was not rejected. Economically disadvantaged students in the experimental chess classes did not improve significantly from pretest to posttest on the Quantitative Reasoning Batteries of the CogAT.

Null Hypothesis 9

There is no significant difference in nonverbal reasoning abilities, as measured with pre-tests and post-tests, for economically disadvantaged students who received formal classroom chess instruction.

Table 9 presents the means and standard deviations for the Nonverbal Battery of the CogAT and the Naglieri Nonverbal Abilities Test of the students identified as economically disadvantaged in the chess instruction group. There were 41 scores in the

CogAT pretest distribution, with a low score of 214 and a high score of 280. The mean of the distribution was 250.02 and the standard deviation was 16.74. There were 41 scores in the CogAT posttest distribution, with a low score of 225 and a high score of 286. The mean of the distribution was higher than the pretest at 250.63 and the standard deviation was similar at 17.09.

There were 41 scores in the NNAT pretest distribution, with a low score of 564 and a high score of 709. The mean of the distribution was 636.51 and the standard deviation was 31.68. There were 41 scores in the NNAT posttest distribution, with a low score of 554 and a high score of 717. The mean of the distribution was higher than the pretest at 645.54 and the standard deviation was similar at 40.23.

Table 9

Descriptives for Nonverbal Results: Economically Disadvantaged Chess Instruction

	N	Min	Max	M	SD
CogAT Pre	41	201	278	235.83	17.37
CogAT Post	41	208	285	242.20	17.76
NNAT Pre	41	564	709	636.51	31.68
NNAT Post	41	554	717	645.54	40.23

A paired-samples t test was conducted to evaluate whether economically disadvantaged students in the experimental chess instruction group significantly improved in nonverbal reasoning abilities. The results indicated that the mean concern for the CogAT nonverbal reasoning posttest ($M = 242.2$, $SD = 17.76$) was significantly greater than the mean concern for the CogAT nonverbal reasoning pretest ($M = 235.83$, $SD = 17.37$), $t\ (40) = -2.92$, $p = .006$. The standardized effect size index, eta squared, was .176, a large value. The null hypothesis 9 was rejected. Students in the

experimental chess classes improved significantly from pretest to posttest on the Nonverbal Reasoning Batteries of the CogAT.

A paired-samples t test was conducted to evaluate whether economically disadvantaged students in the experimental chess instruction group significantly improved in nonverbal reasoning abilities as measured by the Naglieri Nonverbal Abilities Test. The results indicated that the mean concern for the NNAT posttest (M = 645.54, SD = 40.23) was significantly greater than the mean concern for the NNAT pretest (M = 636.51, SD = 31.68), t (40) = -2.07, p = .045. The standardized effect size index, eta squared, was .097, a moderate value. The mean difference was 9.02 points between the NNAT posttest and pretest. The null hypothesis 9 was rejected. Students in the experimental chess classes improved significantly on the Naglieri Nonverbal Abilities Test.

Research Question # 4

Was there a significant difference in verbal, quantitative, and nonverbal reasoning abilities, as measured with pre-tests and post-tests, for economically disadvantaged students who did not receive formal classroom chess instruction?

Null Hypothesis 10

There is no significant difference in verbal reasoning abilities, as measured with pre-tests and post-tests, for economically disadvantaged students who did not receive formal classroom chess instruction.

Table 10 presents the means and standard deviations for the Verbal Battery of the CogAT of the students identified as economically disadvantaged who did not receive chess instruction group. There were 60 scores in the pretest distribution, with a low score

of 207 and a high score of 285. The mean of the distribution was 247.87 and the standard deviation was 16.73. There were 60 scores in the posttest distribution, with a low score of 223 and a high score of 289. The mean of the distribution was higher than the pretest at 250.68 and the standard deviation was similar at 16.3.

Table 10

Descriptives for Verbal Results: Economically Disadvantaged No Chess

	N	Min	Max	M	SD
Verbal Pre	55	219	284	251.35	13.68
Verbal Post	57	211	292	251.56	16.69

A paired-samples t test was conducted to evaluate whether economically disadvantaged students who did not receive chess instruction significantly improved in verbal reasoning abilities. The results indicated that the mean concern for the verbal reasoning posttest ($M = 252.28$, $SD = 17.93$) was not significantly greater than the mean concern for the verbal reasoning pretest ($M = 251.04$, $SD = 14.62$), $t\ (46) = -.62$, $p = .54$. The standardized effect size index, eta squared, was .008, a small value. The null hypothesis 10 was not rejected. Economically disadvantaged students in the non chess control classes did not improve significantly from pretest to posttest on the Verbal Reasoning Batteries of the CogAT.

Null Hypothesis 11

There is no significant difference in quantitative reasoning abilities, as measured with pre-tests and post-tests, for economically disadvantaged students who did not receive formal classroom chess instruction.

Table 11 presents the means and standard deviations for the Quantitative Battery of the CogAT of the students in the chess instruction group. There were 58 scores in the pretest distribution, with a low score of 220 and a high score of 301. The mean of the distribution was 256.72 and the standard deviation was 16.95. There were 52 scores in the posttest distribution, with a low score of 223 and a high score of 308. The mean of the distribution was higher than the pretest at 253.29 and the standard deviation was similar at 19.53.

Table 11

Descriptives for Quantitative Results: Economically Disadvantaged No Chess

	N	Min	Max	M	SD
Quant Pre	58	220	301	256.72	16.95
Quant Post	52	223	308	253.29	19.53

A paired-samples t test was conducted to evaluate whether economically disadvantaged students who did not receive chess instruction significantly improved in quantitative reasoning abilities. The results indicated that the mean concern for the quantitative reasoning posttest ($M = 252.81$, $SD = 19.91$) was not significantly greater than the mean concern for the quantitative reasoning pretest ($M = 256.13$, $SD = 16.29$), $t(46) = 1.95$, $p = .058$. The standardized effect size index, eta squared, was .076, a moderate value. The null hypothesis 11 was not rejected. Economically disadvantaged students in the non chess control classes did not improve significantly from pretest to posttest on the Quantitative Reasoning Batteries of the CogAT.

Null Hypothesis 12

There is no significant difference in nonverbal reasoning abilities, as measured with pre-tests and post-tests, for economically disadvantaged students who did not receive formal classroom chess instruction.

Table 12 presents the means and standard deviations for the Nonverbal Battery of the CogAT and the Naglieri Nonverbal Abilities Test of the students in the chess instruction group. There were 58 scores in the CogAT pretest distribution, with a low score of 194 and a high score of 285. The mean of the distribution was 238.58 and the standard deviation was 17.23. There were 60 scores in the CogAT posttest distribution, with a low score of 208 and a high score of 292. The mean of the distribution was higher than the pretest at 240.88 and the standard deviation was similar at 18.91.

There were 61 scores in the NNAT pretest distribution, with a low score of 554 and a high score of 694. The mean of the distribution was 636.67 and the standard deviation was 32.81. There were 60 scores in the NNAT posttest distribution, with a low score of 572 and a high score of 709. The mean of the distribution was higher than the pretest at 641.62 and the standard deviation was similar at 32.84.

Table 12

Descriptives for Nonverbal Results: Economically Disadvantaged No Chess

	N	Min	Max	M	SD
CogAT Pre	58	194	285	240.88	18.91
CogAT Post	57	208	295	243.02	19.69
NNAT Pre	61	554	694	636.66	32.81
NNAT Post	60	572	709	641.62	32.84

A paired-samples t test was conducted to evaluate whether economically disadvantaged students who did not receive chess instruction significantly improved in nonverbal reasoning abilities. The results indicated that the mean concern for the CogAT nonverbal reasoning posttest (M = 243.85, SD = 20.16) was not significantly greater than the mean concern for the CogAT nonverbal reasoning pretest (M = 241.55, SD = 19.4), t (52) = -1.45, p = .152. The standardized effect size index, eta squared, was .039, a moderate value. The null hypothesis 12 was not rejected. Economically disadvantaged students in the non chess control classes did not improve significantly from pretest to posttest on the Nonverbal Reasoning Batteries of the CogAT.

A paired-samples t test was also conducted to evaluate whether economically disadvantaged students who did not receive chess instruction significantly improved in nonverbal reasoning abilities as measured by the Naglieri Nonverbal Abilities Test. The results indicated that the mean concern for the NNAT posttest (M = 642.29, SD = 33.95) was not significantly greater than the mean concern for the NNAT pretest (M = 638.46, SD = 31.71), t (54) = -1.47, p = .148. The standardized effect size index, eta squared, was .04, a small value. The null hypothesis 12 was not rejected. Economically disadvantaged students in the non chess control classes did not improve significantly from pretest to posttest on the Naglieri Nonverbal Abilities Test.

Research Question # 5

Was there a significant difference in verbal, quantitative, and nonverbal reasoning abilities, as measured with pre-tests and post-tests, for students not identified as economically disadvantaged who received formal classroom chess instruction?

Null Hypothesis 13

There is no significant difference in verbal reasoning abilities, as measured with pre-tests and post-tests, for students not identified as economically disadvantaged who received formal classroom chess instruction.

Table 13 presents the means and standard deviations for the Verbal Battery of the CogAT of the students not identified as economically disadvantaged in the chess instruction group. There were 19 scores in the pretest distribution, with a low score of 213 and a high score of 285. The mean of the distribution was 249.11 and the standard deviation was 18.10. There were 19 scores in the posttest distribution, with a low score of 223 and a high score of 285. The mean of the distribution was higher than the pretest at 254.05 and the standard deviation was similar at 18.02.

Table 13

Descriptives for Verbal Results: Not Economically Disadvantaged Chess Instruction

	N	Min	Max	M	SD
Verbal Pre	19	213	285	249.11	18.10
Verbal Post	19	223	285	254.05	18.02

A paired-samples t test was conducted to evaluate whether students not identified as economically disadvantaged in the experimental chess instruction group significantly improved in verbal reasoning abilities. The results indicated that the mean concern for the verbal reasoning posttest ($M = 254.03$, $SD = 18.02$) was significantly greater than the mean concern for the verbal reasoning pretest ($M = 249.12$, $SD = 18.1$), $t\ (18) = -2.88$, $p = .01$. The standardized effect size index, eta squared, was .061, a moderate value. The null hypothesis 13 was rejected. Students not identified as economically disadvantaged

in the experimental chess classes improved significantly from pretest to posttest on the Verbal Reasoning Batteries of the CogAT.

Null Hypothesis 14

There is no significant difference in quantitative reasoning abilities, as measured with pre-tests and post-tests, for students not identified as economically disadvantaged who received formal classroom chess instruction.

Table 14 presents the means and standard deviations for the Quantitative Battery of the CogAT of the students not identified as economically disadvantaged in the chess instruction group. There were 19 scores in the pretest distribution, with a low score of 234 and a high score of 282. The mean of the distribution was 254.68 and the standard deviation was 14.81. There were 19 scores in the posttest distribution, with a low score of 232 and a high score of 291. The mean of the distribution was higher than the pretest at 257.11 and the standard deviation was similar at 17.20.

Table 14

Descriptives for Quantitative Results: Not Economically Disadvantaged Chess Instruction

	N	Min	Max	M	SD
Quant Pre	19	234	282	254.68	14.81
Quant Post	19	232	291	257.11	17.20

A paired-samples t test was conducted to evaluate whether students not identified as economically disadvantaged in the experimental chess instruction group significantly improved in quantitative reasoning abilities. The results indicated that the mean concern for the quantitative reasoning posttest ($M = 257.11$, $SD = 17.2$) was not significantly

greater than the mean concern for the quantitative reasoning pretest (M = 254.68, SD = 14.81), t (18) = -.8, p = .434. The standardized effect size index, eta squared, was .046, a small value. The null hypothesis 14 was not rejected. Students not identified as economically disadvantaged in the experimental chess classes did not improve significantly from pretest to posttest on the Quantitative Reasoning Batteries of the CogAT.

Null Hypothesis 15

There is no significant difference in nonverbal reasoning abilities, as measured with pre-tests and post-tests, for students not identified as economically disadvantaged who received formal classroom chess instruction.

Table 15 presents the means and standard deviations for the Nonverbal Battery of the CogAT and the Naglieri Nonverbal Abilities Test of the students not identified as economically disadvantaged in the chess instruction group. There were 19 scores in the CogAT pretest distribution, with a low score of 220 and a high score of 278. The mean of the distribution was 244.53 and the standard deviation was 15.75. There were 19 scores in the CogAT posttest distribution, with a low score of 220 and a high score of 292. The mean of the distribution was higher than the pretest at 251 and the standard deviation was similar at 19.05.

There were 19 scores in the NNAT pretest distribution, with a low score of 598 and a high score of 682. The mean of the distribution was 638.9 and the standard deviation was 31.86. There were 19 scores in the NNAT posttest distribution, with a low score of 624 and a high score of 717. The mean of the distribution was higher than the pretest at 657.9 and the standard deviation was similar at 25.97.

Table 15

Descriptives for Nonverbal Results: Not Economically Disadvantaged Chess Instruction

	N	Min	Max	M	SD
CogAT Pre	19	220	278	244.53	15.75
CogAT Post	19	220	292	251.00	19.05
NNAT Pre	19	598	682	638.90	31.86
NNAT Post	19	624	717	657.90	25.97

A paired-samples t test was conducted to evaluate whether students not identified as economically disadvantaged in the experimental chess instruction group significantly improved in nonverbal reasoning abilities. The results indicated that the mean concern for the CogAT nonverbal posttest (M = 251, SD = 19.05) was significantly greater than the mean concern for the CogAT nonverbal pretest (M = 244.53, SD = 15.75), t (18) = -2.35, p = .031. The standardized effect size index, eta squared, was .017, a small value. The null hypothesis 15 was rejected. Students not identified as economically disadvantaged in the experimental chess classes improved significantly from pretest to posttest on the Verbal Reasoning Batteries of the CogAT.

A paired-samples t test was conducted also to evaluate whether students not identified as economically disadvantaged in the experimental chess instruction group significantly improved in nonverbal reasoning abilities as measured by the Naglieri Nonverbal Abilities Test. The results indicated that the mean concern for the NNAT posttest (M = 657.9, SD = 25.97) was significantly greater than the mean concern for the NNAT pretest (M = 638.9, SD = 31.86), t (18) = -2.83, p = .011. The standardized effect size index, eta squared, was .008, a small value. The null hypothesis 15 was rejected.

Students not identified as economically disadvantaged in the experimental chess classes improved significantly from pretest to posttest on the Naglieri Nonverbal Abilities Test.

Research Question # 6

Was there a significant difference in verbal, quantitative, and nonverbal reasoning abilities, as measured with pre-tests and post-tests, for students not identified as economically disadvantaged who did not receive formal classroom chess instruction?

Null Hypothesis 16

There is no significant difference in verbal reasoning abilities, as measured with pre-tests and post-tests, for students not identified as economically disadvantaged who did not receive formal classroom chess instruction.

Table 16 presents the means and standard deviations for the Verbal Battery of the CogAT of the students not identified as economically disadvantaged who did not receive chess instruction. There were 40 scores in the pretest distribution, with a low score of 225 and a high score of 290. The mean of the distribution was 256.33 and the standard deviation was 14.43. There were 34 scores in the posttest distribution, with a low score of 219 and a high score of 287. The mean of the distribution was higher than the pretest at 256.71 and the standard deviation was similar at 15.98.

Table 16

Descriptives for Verbal Results: Not Economically Disadvantaged No Chess

	N	Min	Max	M	SD
Verbal Pre	40	225	290	256.33	14.43
Verbal Post	34	219	287	256.71	15.98

A paired-samples t test was conducted to evaluate whether students not identified as economically disadvantaged in the no chess control group significantly improved in verbal reasoning abilities. The results indicated that the mean concern for the verbal reasoning posttest (M = 256.17, SD = 16.21) was not significantly greater than the mean concern for the verbal reasoning pretest (M = 259.5, SD = 13.93), t (29) = 1.37, p = .18. The standardized effect size index, eta squared, was .008, a small value. The null hypothesis 16 was not rejected. Students not identified as economically disadvantaged in the no chess control classes did not improve significantly from pretest to posttest on the Verbal Reasoning Batteries of the CogAT.

Null Hypothesis 17

There is no significant difference in quantitative reasoning abilities, as measured with pre-tests and post-tests, for students not identified as economically disadvantaged who did not receive formal classroom chess instruction.

Table 17 presents the means and standard deviations for the Quantitative Battery of the CogAT of the students not identified as economically disadvantaged who did not receive chess instruction. There were 40 scores in the pretest distribution, with a low score of 228 and a high score of 298. The mean of the distribution was 259.65 and the standard deviation was 14.28. There were 34 scores in the posttest distribution, with a low score of 230 and a high score of 313. The mean of the distribution was higher than the pretest at 261.06 and the standard deviation was similar at 16.21.

Table 17

Descriptives for Quantitative Results: Not Economically Disadvantaged No Chess

	N	Min	Max	M	SD
Quant Pre	40	228	298	259.65	14.28
Quant Post	34	230	313	261.06	16.21

A paired-samples t test was conducted to evaluate whether students not identified as economically disadvantaged in the no chess control group significantly improved in quantitative reasoning abilities. The results indicated that the mean concern for the quantitative reasoning posttest (M = 263.1, SD = 15.44) was significantly greater than the mean concern for the quantitative reasoning pretest (M = 260.67, SD = 14.82), t (29) = -1.18, p = .249. The standardized effect size index, eta squared, was .078, a large value. The null hypothesis 17 was not rejected. Students not identified as economically disadvantaged in the no chess control classes did not improve significantly from pretest to posttest on the Quantitative Reasoning Batteries of the CogAT.

Null Hypothesis 18

There is no significant difference in nonverbal reasoning abilities, as measured with pre-tests and post-tests, for students not identified as economically disadvantaged who did not receive formal classroom chess instruction.

Table 18 presents the means and standard deviations for the Nonverbal Battery of the CogAT and the Naglieri Nonverbal Abilities Test of the students not identified as economically disadvantaged who did not receive chess instruction. There were 45 scores in the CogAT pretest distribution, with a low score of 213 and a high score of 298. The mean of the distribution was 248.2 and the standard deviation was 19.39. There were 36

scores in the CogAT posttest distribution, with a low score of 205 and a high score of 298. The mean of the distribution was higher than the pretest at 249.06 and the standard deviation was similar at 23.19.

There were 44 scores in the NNAT pretest distribution, with a low score of 579 and a high score of 717. The mean of the distribution was 653.57 and the standard deviation was 30.24. There were 40 scores in the NNAT posttest distribution, with a low score of 572 and a high score of 755. The mean of the distribution was higher than the pretest at 657.95 and the standard deviation was similar at 37.85.

Table 18

Descriptives for Nonverbal Results: Not Economically Disadvantaged No Chess Group

	N	Min	Max	M	SD
CogAT Pre	45	213	298	248.20	19.39
CogAT Post	36	205	298	249.06	23.19
NNAT Pre	44	579	717	653.57	30.24
NNAT Post	40	572	755	657.95	37.85

A paired-samples t test was conducted to evaluate whether students not identified as economically disadvantaged in the no chess control group significantly improved in nonverbal reasoning abilities. The results indicated that the mean concern for the CogAT nonverbal reasoning posttest ($M = 249.63$, $SD = 23.27$) was not significantly greater than the mean concern for the CogAT nonverbal reasoning pretest ($M = 251.43$, $SD = 19.07$), $t(34) = .78$, $p = .443$. The standardized effect size index, eta squared, was .039, a small value. The null hypothesis 18 was not rejected. Students not identified as economically disadvantaged in the no chess control classes did not improve significantly from pretest to posttest on the Nonverbal Reasoning Batteries of the CogAT.

A paired-samples t test was also conducted to evaluate whether students not identified as economically disadvantaged in the no chess control group significantly improved in nonverbal reasoning abilities as measured by the Naglieri Nonverbal Activities Test. The results indicated that the mean concern for the NNAT posttest (M = 659.18, SD = 35.6) was not significantly greater than the mean concern for the NNAT pretest (M = 657.26, SD = 29.51), t (37) = -.54, p = .591. The standardized effect size index, eta squared, was .038, a small value. The null hypothesis 18 was not rejected. Students not identified as economically disadvantaged in the no chess control classes did not improve significantly from pretest to posttest on the Naglieri Nonverbal Activities Test.

Research Question # 7

Was there a significant difference between the pretest-posttest change of performance levels on the verbal reasoning abilities test for students identified as economically disadvantaged and students not identified as economically disadvantaged who received formal classroom chess instruction and students who did not receive chess instruction?

A two-way univariate of variance (ANOVA) was conducted to determine the difference in the mean verbal reasoning scores as measured by the Verbal Battery of the CogAT for: (a) all economically disadvantaged students from both groups and all students not economically disadvantaged from both groups, (b) all students who received chess instruction and all students who did not receive chess instruction, and (c) interaction between subject effects of chess instruction versus no chess instruction and

students identified as economically disadvantaged versus students not identified as economically disadvantaged.

Table 19 presents the difference in means and standard deviations for the comparisons listed in the previous paragraph. There were 88 sets of scores for all economically disadvantaged students with a mean difference of 1.32 and standard deviation of 9.21, and 49 sets of scores for not economically disadvantaged students with a mean difference of -.12 and standard deviation of 12.02.There were 60 sets of scores in the chess instruction group with a mean difference of 2.82 and standard deviation of 8.42, and 77 sets of scores in the group not receiving chess instruction with a mean difference of -.77 and standard deviation of 11.34.

Table 19

Descriptives of Two-way Analysis of Variance for Verbal Battery of the CogAT

Econ. Disadv.	Group	M	SD	N
Yes	Chess	1.83	8.73	41
	No chess	.87	9.69	47
	Total	1.32	9.21	88
No	Chess	4.95	7.48	19
	No Chess	-3.33	13.3	30
	Total	-.12	12.02	49
Total	Chess	2.82	8.42	60
	No Chess	-.77	11.34	77
	Total	.80	10.28	137

Null Hypothesis 19

There is no significant difference between the pretest-posttest change of performance levels on verbal reasoning abilities for all students identified as

economically disadvantaged and all students not identified as economically disadvantaged.

A two-way univariate of variance (ANOVA) was conducted to determine the difference in the mean verbal reasoning scores between students identified as economically disadvantaged and students not identified as economically disadvantaged as measured by the Verbal Battery of the CogAT. Table 20 presents the between-subject effects for the Verbal Battery of the CogAT. The ANOVA did not indicate a significant main effect, F (1, 133) = .09, p = .767, and eta squared was .001, a small value. The null hypothesis 19 was not rejected. Students from both the chess and no chess groups identified as economically disadvantaged did not improve significantly from the pretest to posttest of the Verbal Battery of the CogAT compared to students not identified as economically disadvantaged in both the chess and no chess groups.

Null Hypothesis 20

There is no significant difference between the pretest-posttest change of performance levels on verbal reasoning abilities for students who received formal classroom chess instruction and students who did not receive chess instruction.

A two-way univariate of variance (ANOVA) was conducted to determine the difference in the mean verbal reasoning scores between students who received classroom chess instruction and students who did not receive chess instruction as measured by the Verbal Battery of the CogAT. Table 20 presents the between-subject effects for the Verbal Battery of the CogAT. The ANOVA indicated a significant main effect, F (1, 133) = 6.39, p = .013, and eta squared was .046, a moderate value. The null hypothesis 20 was rejected. Students who received chess instruction improved significantly from the

pretest to the posttest on the Verbal Battery of the CogAT compared to students who did not receive chess instruction.

Null Hypothesis 21

There is no significant interaction between subject effects of chess instruction versus no chess instruction and students identified as economically disadvantaged versus students not identified as economically disadvantaged on the pretest-posttest change of performance levels on verbal reasoning abilities.

The interaction between socioeconomic classification and chess instruction group for null hypothesis 21 was evaluated using the two-factor ANOVA. Table 20 presents the between-subject effects for the Verbal Battery of the CogAT. The ANOVA indicated a significant interaction between socioeconomic classification and chess instruction, $F(1,133) = 4.02$, $p = .047$, eta squared was .029, a small value. The null hypothesis 21 was rejected. Students identified economically disadvantaged and not identified economically disadvantaged who received chess instruction improved significantly from pretest to posttest on the Verbal Battery of the CogAT compared to the changes in scores for both socioeconomic groups in the no chess control group. The interaction indicated that students not identified as economically disadvantaged in the chess instruction group had greater improvement in verbal reasoning ability than those identified as economically disadvantaged in the chess instruction group.

Table 20

Two-way Analysis of Variance for Verbal Battery of the CogAT

Source	Sum of Squares	df	Mean Square	F	Sig.	Eta Squared
EconDisadv	8.99	1	8.99	.09	.767	.001
Group	648.28	1	648.28	6.39	.013*	.046
EconDisadv * Group	407.48	1	407.48	4.02	.047*	.029
Error	13498.65	133	101.49			

*p<.05

Research Question # 8

Was there a significant difference between the pretest-posttest change of performance levels on the quantitative reasoning abilities test for students identified as economically disadvantaged and students not identified as economically disadvantaged who received formal classroom chess instruction and students who did not receive chess instruction?

A two-way univariate of variance (ANOVA) was conducted to determine the difference in the mean quantitative reasoning scores as measured by the Quantitative Battery of the CogAT for: (a) all economically disadvantaged students from both groups and all students not economically disadvantaged from both groups, (b) all students who received chess instruction and all students who did not receive chess instruction, and (c) interaction between subject effects of chess instruction versus no chess instruction and students identified as economically disadvantaged versus students not identified as economically disadvantaged.

Table 21 presents the difference in means and standard deviations for the comparisons listed in the previous paragraph. There were 88 sets of scores for all economically disadvantaged students with a mean difference of -1.49 and standard deviation of 13.02, and 49 sets of scores for not economically disadvantaged students with a mean difference of 2.43 and standard deviation of 11.95.There were 60 sets of scores in the chess instruction group with a mean difference of 1.18 and standard deviation of 13.84, and 77 sets of scores in the group not receiving chess instruction with a mean difference of -1.08 and standard deviation of 11.82.

Table 21

Descriptives of Two-way Analysis of Variance for Quantitative Battery of the CogAT

Econ. Disadv.	Group	M	SD	N
Yes	Chess	.61	14.25	41
	No chess	-3.32	11.7	47
	Total	-1.49	13.02	88
No	Chess	2.42	13.2	19
	No chess	2.43	11.32	30
	Total	2.43	11.95	49
Total	Chess	1.18	13.84	60
	No chess	-1.08	11.82	77
	Total	-8.76	12.75	137

Null Hypothesis 22

There is no significant difference between the pretest-posttest change of performance levels on quantitative reasoning abilities for all students identified as economically disadvantaged and all students not identified as economically disadvantaged.

A two-way univariate of variance (ANOVA) was conducted to determine the difference in the mean quantitative reasoning scores between students identified as

economically disadvantaged and all students not identified as economically disadvantaged as measured by the Quantitative Battery of the CogAT. Table 22 presents the between-subject effects for the Quantitative Battery of the CogAT. The ANOVA did not indicate a significant main effect, F (1, 133) = 2.72, p = .102, and eta squared was .02, a moderate value. The null hypothesis 22 was not rejected. Students from both the chess and no chess groups identified as economically disadvantaged did not improve significantly from the pretest to posttest on the Quantitative Battery of the CogAT compared to students not identified as economically disadvantaged in both the chess and no chess groups.

Null Hypothesis 23

There is no significant difference between the pretest-posttest change of performance levels on quantitative reasoning abilities for students who received formal classroom chess instruction and students who did not receive chess instruction.

A two-way univariate of variance (ANOVA) was conducted to determine the difference in the mean quantitative reasoning scores between students who received chess instruction and students who did not receive chess instruction as measured by the Quantitative Battery of the CogAT. Table 22 presents the between-subject effects for the Quantitative Battery of the CogAT. The ANOVA did not indicate a significant main effect, F (1, 133) = .73, p = .395, and eta squared was .005, a small value. The null hypothesis 23 was not rejected. Students who received chess instruction did not improve significantly from the pretest to the posttest of the Quantitative Battery of the CogAT compared to students who did not receive chess instruction.

Null Hypothesis 24

There is no significant interaction between subject effects of chess instruction versus no chess instruction and students identified as economically disadvantaged versus students not identified as economically disadvantaged on the pretest-posttest change of performance levels on quantitative reasoning abilities.

The interaction between socioeconomic classification and chess instruction group for null hypothesis 24 was evaluated using the two-factor ANOVA. Table 22 presents the between-subject effects for the Quantitative Battery of the CogAT. The ANOVA did not indicate a significant interaction between socioeconomic classification and chess instruction, F (1, 133) = .74, p = .392, eta squared was .006, a small value. Students identified economically disadvantaged and not identified economically disadvantaged who received chess instruction did not improve significantly from pretest to posttest on the Quantitative Battery of the CogAT compared to the changes in scores for both socioeconomic groups in the no chess control group. Although the interaction was not statistically significant, students not identified as economically disadvantaged in the chess instruction group had greater improvement in quantitative reasoning ability than those identified as economically disadvantaged in the chess instruction group.

Table 22

Two-way Analysis of Variance for Quantitative Battery of the CogAT

Source	Sum of Squares	df	Mean Square	F	Sig.	Eta Squared
EconDisadv	434.63	1	434.63	2.72	.102	.020
Group	116.54	1	116.54	.73	.395	.005
EconDisadv * Group	118.00	1	118.00	.74	.392	.006
Error	21269.98	133	159.93			

*p<.05

Research Question # 9

Was there a significant difference between the pretest-posttest change of performance levels on the quantitative reasoning abilities test for students identified as economically disadvantaged and students not identified as economically disadvantaged who received formal classroom chess instruction and students who did not receive chess instruction?

A two-way univariate of variance (ANOVA) was conducted to determine the difference in the mean nonverbal reasoning scores as measured by both the Nonverbal Battery of the CogAT and the Nagilieri Nonverbal Abilities Test for: (a) all economically disadvantaged students from both groups and all students not economically disadvantaged from both groups, (b) all students who received chess instruction and all students who did not receive chess instruction, and (c) interaction between subject effects of chess instruction versus no chess instruction and students identified as economically disadvantaged versus students not identified as economically disadvantaged.

Table 23 presents the difference in means and standard deviations for the comparisons listed in the previous paragraph for the Nonverbal Battery of the CogAT. There were 94 sets of scores for all economically disadvantaged students with a mean difference of 4.08 and standard deviation of 12.73, and 54 sets of scores for not economically disadvantaged students with a mean difference of 1.11 and standard deviation of 13.63. There were 60 sets of scores in the chess instruction group with a mean difference of 6.4 and standard deviation of 13.26, and 88 sets of scores in the group not receiving chess instruction with a mean difference of .67 and standard deviation of 12.54.

Table 23

Descriptives of Two-way Analysis of Variance for Nonverbal Battery of the CogAT

Econ. Disadv.	Group	M	SD	N
Yes	Chess	6.37	13.94	41
	No chess	2.30	11.54	53
	Total	4.08	12.73	94
No	Chess	6.47	12.02	19
	No chess	-1.80	13.73	35
	Total	1.11	13.63	54
Total	Chess	6.40	13.26	60
	No chess	.67	12.54	88
	Total	2.99	13.10	148

A two-way univariate of variance (ANOVA) was also conducted to determine the difference in the mean nonverbal reasoning scores as measured by the Naglieri Nonverbal Abilities Test. Table 24 presents the difference in means and standard deviations for the NNAT. There were 96 sets of scores for all economically disadvantaged students with a mean difference of 6.05 and standard deviation of 23.44, and 57 sets of scores for not economically disadvantaged students with a mean difference of 7.61 and standard

deviation of 25.62. There were 60 sets of scores in the chess instruction group with a mean difference of 12.18 and standard deviation of 28.51, and 93 sets of scores in the group not receiving chess instruction with a mean difference of 3.05 and standard deviation of 20.33.

Table 24

Descriptives of Two-way Analysis of Variance for Naglieri Nonverbal Abilities Test

Econ. Disadv.	Group	M	SD	N
Yes	Chess	9.02	27.94	41
	No chess	3.84	19.4	55
	Total	6.05	23.44	96
No	Chess	19.0	29.29	19
	No chess	1.92	21.82	38
	Total	7.61	25.62	57
Total	Chess	12.18	28.51	60
	No chess	3.05	20.33	93
	Total	6.63	24.20	153

Null Hypothesis 25

There is no significant difference between the pretest-posttest change of performance levels on nonverbal reasoning abilities for all students identified as economically disadvantaged and all students not identified as economically disadvantaged.

A two-way univariate of variance (ANOVA) was conducted to determine the difference in the mean nonverbal reasoning scores between students identified as economically disadvantaged and students not identified as economically disadvantaged as measured by the Nonverbal Battery of the CogAT. Table 25 presents the between-subject effects for the Nonverbal Battery of the CogAT. The ANOVA did not indicate a

significant main effect, F (1, 144) = .78, p = .379, and eta squared was .005, a small value. The null hypothesis 25 was not rejected. Economically disadvantaged students in both the chess and no chess groups did not improve significantly from the pretest to the posttest on the Nonverbal Battery of the CogAT compared to students not identified as economically disadvantaged in both the chess and no chess groups.

A two-way univariate of variance (ANOVA) was also conducted to determine the difference in the mean nonverbal reasoning scores between students identified as economically disadvantaged and students not identified as economically disadvantaged as measured by the Naglieri Nonverbal Abilities Test. Table 26 presents the between-subject effects for the NNAT. The ANOVA did not indicate a significant main effect, F (1, 149) = .94, p = .333, and eta squared was .006, a small value. The null hypothesis 25 was not rejected. Economically disadvantaged students in both the chess and no chess groups did not improve significantly from the pretest to the posttest on the NNAT compared to students not identified as economically disadvantaged in both the chess and no chess groups.

Null Hypothesis 26

There is no significant difference between the pretest-posttest change of performance levels on nonverbal reasoning abilities for students who received formal classroom chess instruction and students who did not receive chess instruction.

A two-way univariate of variance (ANOVA) was conducted to determine the difference in the mean nonverbal reasoning scores between students who received chess instruction and students who did not receive chess instruction as measured by the Nonverbal Battery of the CogAT. Table 25 presents the between-subject effects for the

Nonverbal Battery of the CogAT. The ANOVA indicated a significant main effect, F (1, 149) = 7.19, p = .008, and eta squared was .046, a moderate value. The null hypothesis 26 was rejected. Students who received chess instruction improved significantly from the pretest to the posttest on the Nonverbal Battery of the CogAT compared to students who did not receive chess instruction.

A two-way univariate of variance (ANOVA) was also conducted to determine the difference in the mean nonverbal reasoning scores between students who received chess instruction and students who did not receive chess instruction as measured by the Naglieri Nonverbal Abilities Test. Table 26 presents the between-subject effects for the Nonverbal Battery of the CogAT. The ANOVA indicated a significant main effect, F (1, 144) = 7.43, p = .007, and eta squared was .049, a moderate value. The null hypothesis 26 was rejected. Students who received chess instruction improved significantly from the pretest to the posttest on the NNAT compared to students who did not receive chess instruction.

Null Hypothesis 27

There is no significant interaction between-subject effects of chess instruction versus no chess instruction and students identified as economically disadvantaged versus students not identified as economically disadvantaged on the pretest-posttest change of performance levels on nonverbal reasoning abilities.

The interaction between socioeconomic classification and chess instruction group for null hypothesis 27 was evaluated using the two-factor ANOVA. The ANOVA did indicate a significant interaction between socioeconomic classification and chess instruction for the Nonverbal Battery of the CogAT, F (1, 144) = .87, p = .354, eta

squared was .006, a small value. Students identified as economically disadvantaged and not economically disadvantaged who received chess instruction improved significantly from pretest to posttest on the Nonverbal Battery of the CogAT compared to the changes in scores for both socioeconomic groups in the no chess control group. The interaction indicated that students not identified as economically disadvantaged in the chess instruction group had greater improvement in nonverbal reasoning ability than those identified as economically disadvantaged in the chess instruction group.

The interaction between socioeconomic classification and chess instruction group for null hypothesis 27 was evaluated using the two-factor ANOVA. The ANOVA did not indicate a significant interaction between socioeconomic classification and chess instruction on the Naglieri Nonverbal Abilities Test, F (1, 149) = 2.05, p = .154, eta squared was .014, a moderate value. Students identified as economically disadvantaged and not economically disadvantaged who received chess instruction improved significantly from pretest to posttest on the NNAT compared to the changes in scores for both socioeconomic groups in the no chess control group. The interaction indicated that students not identified as economically disadvantaged in the chess instruction group had greater improvement in nonverbal reasoning ability than those identified as economically disadvantaged in the chess instruction group.

Table 25

Two-way Analysis of Variance for Nonverbal Battery of the CogAT

Source	Sum of Squares	df	Mean Square	F	Sig.	Eta Squared
EconDisadv	128.17	1	128.17	.78	.379	.005
Group	1223.01	1	1223.01	7.43	.007*	.049
EconDisadv * Group	142.39	1	142.39	.865	.354	.006
Error	23703.02	144	164.60			

*p<.05

Table 26

Two-way Analysis of Variance for Naglieri Nonverbal Abilities Test

Source	Sum of Squares	df	Mean Square	F	Sig.	Eta Squared
EconDisadv	534.634	1	534.634	.942	.333	.006
Group	4080.155	1	4080.155	7.186	.008*	.046
EconDisadv * Group	1163.551	1	1163.551	2.049	.154	.014
Error	84599.266	149	567.780			

*p<.05

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This chapter offers a brief summary of the data analysis, conclusions based on the data analysis, contributions this study makes to the professional literature, and recommendations on how to use chess instruction to improve the problem solving skills of economically disadvantaged students. Recommendations for future research topics are also presented.

Summary

The purpose of this study was to investigate and test the impact of classroom chess instruction on the problem solving skills of economically disadvantaged students. Because of the impact of high stakes standardized testing on economically disadvantaged students, many schools find themselves dealing with the dilemma of meeting the short term demands of the state exams while also providing the enriched curriculum necessary for the development of cognitive skills (McNeil & Valenzuela, 1998). Research indicated that economically disadvantaged students enter the school system deficient in cognitive skills essential to long term learning (Stipek & Ryan, 1997). Therefore, the development of cognitive skills is essential to the academic achievement of many economically disadvantaged students.

The long history of chess research by psychologists and recent research on chess in education indicates that there is potential in using chess as an enrichment activity to promote the development of cognitive skills. This study focused on the cognitive skill of problem solving. The transference of problem solving to other academic subjects was beyond the scope of this study, but is nevertheless the eventual goal of the chess

instruction. Before determining the impact of chess instruction on the math or reading abilities of economically disadvantaged students, it was determined that this study should focus on nonverbal reasoning abilities first, thus the use of two nonverbal measurements and one each for verbal and quantitative reasoning. The results of the statistical analysis were consistent with many aspects of the review of literature, and offers insight to the value and potential of chess in the educational setting.

Analysis of Data Summary

The focus of this study was improvement in verbal, quantitative, and nonverbal reasoning abilities of economically disadvantaged students as a result of classroom chess instruction. There were four dependent variables (Verbal, Quantitative, and Nonverbal Batteries of the CogAT, and the NNAT). Data was collected for pretest to posttest improvement using the paired-samples t test for: (a) all students receiving chess instruction, (b) all students not receiving chess instruction, (c) economically disadvantaged students receiving chess instruction, (d) economically disadvantaged students not receiving chess instruction, (e) students not identified as economically disadvantaged receiving chess instruction, and (f) students not identified as economically disadvantaged not receiving chess instruction. Data was also collected using the two-way analysis of variance to test for between subject effects. The following is a summary of the data analysis:

Verbal Reasoning

Statistically significant improvements of verbal reasoning abilities were found for all students in the experimental chess instruction group, but not for the control group that did not receive chess instruction. The economically disadvantaged students in the chess

instruction group did not show improvement, but students not identified as economically disadvantaged did show significant improvement. The group not receiving chess instruction did not show improvement in either of the socioeconomic categories. The two-way analysis of variance also revealed a significant difference between the groups, with the chess instruction group improving on the change in pretest-posttest performance levels significantly more then the students without chess instruction. The interaction between socioeconomic classification and instruction group showed that the students not identified as economically disadvantaged had significant improvements in comparison to their economically disadvantaged classmates.

Quantitative Reasoning

There were no significant improvements on the quantitative reasoning tests in either socioeconomic category or instruction group as measured by the paired-samples t tests. Neither were there significant changes in pretest-posttest performance levels, or interactions between socioeconomic category and instruction group, as measured by the two-way analysis of variance. The two-way analysis of variance did not reveal statistical significance but it did indicate that economically disadvantaged students in the chess instruction group had a greater improvement over their control group counterparts than did the students not identified as economically disadvantaged in the chess instruction group over their control group counterparts.

Nonverbal Reasoning CogAT

Statistically significant improvements of nonverbal reasoning abilities were found for all students in the experimental chess instruction group, but not for the control group that did not receive chess instruction. Both socioeconomic categories in the chess

instruction group showed statistically significant improvement on the Nonverbal Battery of the CogAT. Neither socioeconomic category of the no-chess group showed significant improvement. The two-way analysis of variance showed significant improvement in the change from pretest-posttest performance levels between the chess and no chess groups. As with the verbal reasoning test, the two-way analysis of variance interaction showed the greatest improvement for students not identified as economically disadvantaged in the chess instruction group over their counterparts in the control group.

Naglieri Nonverbal Abilities Test

The results for the NNAT paralleled the Nonverbal CogAT. Statistically significant improvements of nonverbal reasoning abilities were found for all students in the experimental chess instruction group, but not for the control group that did not receive chess instruction. Both socioeconomic categories in the chess instruction group showed statistically significant improvement on the Nonverbal Battery of the CogAT. Neither socioeconomic category of the no-chess group showed significant improvement. The two-way analysis of variance showed significant improvement in the change from pretest-posttest performance levels between the chess and no chess groups. As with the verbal reasoning test, the two-way analysis of variance interaction showed the greatest improvement for students not identified as economically disadvantaged in the chess instruction group over their counterparts in the control group.

Conclusions

The conclusions drawn from the verbal, quantitative and nonverbal reasoning test results indicate that chess instruction, overall, had the greatest impact on students not identified as economically disadvantaged. These students showed statistically significant

improvements in verbal and both nonverbal measurements. In all three types of reasoning (verbal, quantitative, and nonverbal) the not economically disadvantaged students in the chess classes showed much larger improvements in the pretest-posttest change of performance levels over their no chess counterparts than the economically disadvantaged students over their no chess counterparts.

The focus of this study, however, was the economically disadvantaged students. Although the conclusion was drawn that students not economically disadvantaged benefited greatly from chess instruction, the results for economically disadvantaged students were in line with the review of literature: Improvements in nonverbal problem solving represent cognitive development toward the goal of academic achievement. Agreement between both nonverbal measurements allows strengthens the conclusion that chess develops the nonverbal problem solving abilities of economically disadvantaged students.

The results of the data analysis have offered the following findings for the impact of chess instruction on verbal, quantitative, and nonverbal reasoning:

Findings for Verbal Reasoning

From these statistical analyses a conclusion can be drawn that despite low expectations for statistically significant improvements in verbal reasoning, students in the chess instruction group who are not economically disadvantaged improved significantly in verbal reasoning after thirteen weeks of classroom chess instruction. These results are consistent with the review of literature that found verbal improvements in middle and upper socioeconomic students, but adds to the literature because of the shorter period of instruction than the 1 to 2 year studies detailed in the review of literature. The significant

improvement for students not economically disadvantaged but not for the economically disadvantaged students suggests that economically disadvantaged students may need more time for transference.

Findings for Quantitative Reasoning

There was no statistical significance for improvements in quantitative reasoning anywhere in this study. Expectations for significant improvements after only thirteen weeks of chess instruction were low. As with the verbal reasoning results, transference of problem solving to quantitative abilities in the review of literature appears to take more time than the thirteen weeks allotted in this study. However, the larger change in the mean difference from pretest to posttest for the economically disadvantaged students in the chess instruction group over the not economically disadvantaged students suggests that there is potential for chess instruction to improve quantitative reasoning abilities. Researchers will need to conduct further studies to determine the length of instruction needed for chess problem solving to transfer to quantitative reasoning ability for economically disadvantaged students.

Findings for Nonverbal Reasoning

The purpose of this study was to measure the impact of chess instruction on economically disadvantaged students, and thus the need for nonverbal measurements. The statistical data for both the Nonverbal Reasoning Battery of the CogAT and the Naglieri Nonverbal Abilities test revealed statistically significant improvement throughout the chess instruction group on both nonverbal tests. There were no significant improvements for the no-chess instruction control group on either nonverbal test. This data drawn from two separate nonverbal measurements overwhelmingly supports the

conclusion that chess instruction had an impact on the nonverbal reasoning abilities of students in the chess classes, but specifically for economically disadvantaged students, and, therefore, improved their academic potential.

Contributions to the Professional Literature

The professional literature on the educational benefits of chess had many promising studies but most of them suffered from either a dependent variable that is no longer relevant or a sample size too small for statistical analysis. Studies in the literature also inferred that chess was beneficial for all students, and therefore should be implemented in schools as standardized practice. No literature existed on the effect of chess on economically disadvantaged students. This study contributes to the professional literature foremost because it specifically targets the impact of chess on economically disadvantaged students. This study also used a sample size large enough for statistical analysis and used dependent variables relevant to the educational needs of the economically disadvantaged students that were the focus of the study.

The sample-size used in this study alone makes this study one of the few statistically relevant studies available on the value of chess in education. This study also contributes to the review of literature because it places the need for chess instruction within the context of a larger educational problem: the deficient cognitive development of economically disadvantaged students and the problems those students face in an educational climate of high-stakes standardized testing. Students from middle and upper socio-economic backgrounds already have high levels of academic achievement in comparison to economically disadvantaged children. This study drew attention to the

fact that chess does not have to be for everyone, and addressed a specific audience (economically disadvantaged students) for whom chess might have the greatest benefits.

Finally, this study contributes to the professional literature because of the parallels revealed between chess play and the constructivist model of learning. The introduction of constructivist thinking into the literature on chess and education demonstrated the importance of chess instruction, not just unsupervised play, to the development of cognitive skills. Researchers of chess and education have proposed that chess should be offered during the regular hours of the school day based on inferences, but this study was the first study to offer reasons based on educational theory.

Recommendations

Recommendations for the use of chess to improve academic achievement of economically disadvantaged students are divided into two categories: recommendations for educators, and recommendations for future studies on how chess research could effect academic achievement for economically disadvantaged students.

Recommendations for Educators

- Although a one semester study was the most feasible format to deliver chess instruction as an elective at the middle school level, it is recommended that two semesters of instruction is needed for economically disadvantaged students to allow for the development of chess skill at a much higher level.
- Teachers should use the rating system component of the "Manager" in the "Think Like A King" software as part of the class curriculum to provide a system for students to monitor their own progress.

- It is recommended that a graphic of the Prediction Cycle be posted and referred to in the chess classroom as a visual reminder to the students of the steps of problem solving. The graphic can be used in decision making related to candidate moves in chess and will assist in the objective of teaching for transfer.
- It is recommended that teachers be trained at the beginning of the semester that the objective of the class is not to develop good chess players but to develop good problem solvers. Teachers, therefore, would be more conscientious of teaching for transfer.
- It is recommended that a journal component be added to the curriculum to develop metacognition skills. Students would be allowed to reflect about games played or respond to questions about how to problem solve in a classroom and/or home setting.

Recommendations for Further Study

- It is recommended that a replication of this study be conducted over the course of two semesters to investigate the length of time for chess instruction needed by economically disadvantaged students to statistically improve on the verbal and quantitative reasoning tests. This would add to the literature in regards to program structure for schools interested in offering chess classes
- It is recommended that chess be offered and studied by researchers at the primary grade levels before the effects of cognitive deficiencies establish a trajectory of low achievement for economically disadvantaged students.
- It is recommended that the use of a graphic organizer to teach the Prediction Cycle should be studied as an effective teaching tool in the chess classroom. A study should be conducted with chess instruction using the Prediction Cycle to teach for transfer as

the experimental group, and chess instruction without the Prediction Cycle as the control group.

- It is recommended that the Smith and Sullivan (1997) study on field dependence and field independence and the learning styles of economically disadvantaged students, be replicated with a more rigorous methodology.
- It is recommended that research be conducted on the effects of chess on control motive which could provide needed research on the affective benefits of chess instruction.
- It is recommended that a study be conducted comparing metacognitive abilities of students who reviewed notated games with the chess instructor compared to students who do not go over notated games. The process of a chess instructor going over a notated game with a chess player provides opportunities for several effective pedagogical strategies such as open ended questions, hinting, and articulation of the thought process.
- It is recommended that the theory of Control Motive be studied in the context of chess and the development of economically disadvantaged students' emotional intelligence.
- It is recommended that the Constructivist view of the importance of social setting be studied in regards to chess instruction. This could be done with classroom chess instruction compared to chess instruction that does not take place in the classroom setting.
- It is recommended that the Constructivist view of cognition be more closely examined for parallels to the cognitive processes involved in chess.

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APPENDIX A

National Poverty Rank for South Texas Counties

Counties in South Texas with National Ranking for Most Impoverished Counties in the United States

Starr County (1st)

Zavala County (4th)

Dimmit County (8th)

Maverick County (10th)

Willacy County (11th)

Brooks County (14th)

Hidalgo County (16th)

La Salle County (28th)

Cameron County (29th)

Frio County (32nd)

Webb County (52nd)

Zapata County (57th)

Duval County (59th)

Edwards County (69th)

Jim Hogg County (75th)

Karnes County (77th).

Source: United States Census Bureau (2001). "Small Area Income and Poverty Estimates Counties That Could Be Identified as the Poorest County in the U.S. in 1997"

APPENDIX B

TAAS Passing Percentages

TAAS Passing Rates: An Historical and Comparative Review

A review of the T.E.A. website Student Assessment Division revealed valuable information about the success rates of economically disadvantaged students. Data retrieved from 4th, 8th, and 10th grades indicated that over the eight-year testing period for TAAS, scores for all ethnic groups and economically disadvantaged students have gone up. In all three grade levels, reading and math growth for African American and Hispanic passing percentages is mirrored by the growth of economically disadvantaged passing percentages.

Table B1. TAAS Percent Meeting Minimum Expectations, 4th Grade Reading

	1994	1995	1996	1997	1998	1999	2000	20001
White	83	86	83	86	92	94	95	95
Hispanic	64	70	66	71	81	84	85	87
African Am.	56	61	60	66	77	79	82	83
Economically Disadvantaged	61	67	64	69	79	82	84	85

Table B1 presents data on fourth grade reading TAAS scores over the last eight years. If TAAS was the only measure of student achievement, then minorities and economically disadvantaged students have increased levels of achievement. Perhaps more importantly, at this time, is the visual comparison Table 1 allows the reader to make. First, double-digit gaps between Whites and the other groups still existed after the 2001 tests. Also, the similarity in scores of African American, Hispanic, and economically disadvantaged students supports research that identifies socio-economic

status as a more relevant barrier to academic achievement than ethnicity (Desimone, 1999). The following tables presented a similar pattern regardless of the grade level, subject area standardized test (TAAS).

Table B2. TAAS Percent Meeting Minimum Expectations, 4th Grade Math

	1994	1995	1996	1997	1998	1999	2000	20001
White	86	84	86	89	90	94	95	96
Hispanic	61	60	62	70	71	81	83	87
African Am.	58	57	60	70	72	81	83	87
Economically Disadvantaged	59	57	60	68	70	80	82	86

Table B2 presents data on fourth grade math TAAS scores over the last eight years. Hispanic, African American, and economically disadvantaged categories started at similarly low levels, experienced similar growth on a yearly basis, and still had near double-digit deficits in 2001.

Table B3. TAAS Percent Meeting Minimum Expectations, 8th Grade Reading

	1994	1995	1996	1997	1998	1999	2000	20001
White	86	84	86	89	90	94	95	96
Hispanic	61	60	62	70	71	81	83	87
African Am.	58	57	60	70	72	81	83	87
Economically Disadvantaged	59	57	60	68	70	80	82	86

Table B3 presents data on eighth grade reading TAAS scores over the last eight years. Hispanic, African American, and economically disadvantaged categories started at

similarly low levels, experienced similar growth on a yearly basis, and still had near double-digit deficits in 2001.

Table B4. TAAS Percent Meeting Minimum Expectations, 8th Grade Math

	1994	1995	1996	1997	1998	1999	2000	20001
White	70	70	78	83	86	92	95	96
Hispanic	40	37	52	61	71	80	86	89
African Am.	32	30	44	55	67	74	81	85
Economically Disadvantaged	37	35	49	59	69	78	84	87

Table B4 presents data on eighth grade math TAAS scores over the last eight years. Hispanic, African American, and economically disadvantaged categories started at similarly low levels, experienced similar growth on a yearly basis, and still had near double-digit deficits in 2001.

Table B5. TAAS Percent Meeting Minimum Expectations, 8th Grade Writing

	1994	1995	1996	1997	1998	1999	2000	20001
White	77	82	83	85	87	91	91	91
Hispanic	55	61	61	67	71	79	76	79
African Am.	50	58	61	65	71	78	76	79
Economically Disadvantaged	52	59	59	65	69	77	75	78

Table B5 presents data on eighth grade writing TAAS scores over the last eight years. Hispanic, African American, and economically disadvantaged categories started at

similarly low levels, experienced similar growth on a yearly basis, and still had double-digit deficits in 2001.

Table B6. TAAS Percent Meeting Minimum Expectations, 10th Grade Reading

	1994	1995	1996	1997	1998	1999	2000	20001
White	86	86	89	92	93	95	96	96
Hispanic	61	60	67	73	77	80	83	83
African Am.	60	58	69	76	78	83	85	83
Economically Disadvantaged	58	57	65	71	75	79	82	82

Table B6 presents data on tenth grade reading TAAS scores over the last eight years. Hispanic, African American, and economically disadvantaged categories started at similarly low levels, experienced similar growth on a yearly basis, and still had double-digit deficits in 2001.

Table B7. TAAS Percent Meeting Minimum Expectations, 10th Grade Math

	1994	1995	1996	1997	1998	1999	2000	20001
White	68	71	75	81	85	89	93	94
Hispanic	40	42	51	57	65	73	80	83
African Am.	32	35	43	51	58	66	74	79
Economically Disadvantaged	39	40	49	55	63	71	79	82

Table B7 presents data on tenth grade math TAAS scores over the last eight years. Hispanic, African American, and economically disadvantaged categories started at

similarly low levels, experienced similar growth on a yearly basis, and still had double-digit deficits in 2001.

Table B8. TAAS Percent Meeting Minimum Expectations, 10th Grade Writing

	1994	1995	1996	1997	1998	1999	2000	20001
White	86	84	86	89	90	94	95	96
Hispanic	61	60	62	70	71	81	83	87
African Am.	58	57	60	70	72	81	83	87
Economically Disadvantaged	59	57	60	68	70	80	82	86

Table B8 presents data on tenth grade writing TAAS scores over the last eight years. Hispanic, African American, and economically disadvantaged categories started at similarly low levels, experienced similar growth on a yearly basis, and still had near double-digit deficits in 2001.

APPENDIX C

End-of-Course Passing Percentages

Tables C1 through C8 present data for End-of-Course exams, given three times a year. The scores represented the last two years for a total of six test administrations. Some of the End-of-Course subject exams have been required for more than two years, but the scores for minorities and economically disadvantaged students were even lower for those years. Using the last two years for all of the subject areas allows for a consistent comparison for the similarities between Hispanic and African American scores and the economically disadvantaged scores. Even when scores for White students dropped dramatically, the other sets of scores experienced a similar drop, maintaining double-digit gaps that extended as much as 20 to 30 percentage points in difference. Unlike the TAAS exams that have altered the structure of school organizations in low-income districts as a means to "teach to the test," teaching to the test has not yet become institutionalized for End-of-Course exams (Hurwitz, 2000). The End-of-Course exams are primarily taken at the high school level, so despite reduced gaps in TAAS scores between economically disadvantaged students and minority students, thinking skills that transfer as learning skills to other subject areas do not appear to be occurring. In fact, a visual comparison indicates that the End-of-Course exam gaps between White students and all other categories were as large as the TAAS gaps from eight years earlier, prior to teaching to the test.

Table C1

U.S. History Percent Meeting Minimum Expectations, 1999

	1999 Spring	1999 Summer	1999 Fall
White	84	83	83
Hispanic	56	67	57
African Am.	56	54	55
Economically Disadvantaged	53	62	54

Table C2

U.S. History Percent Meeting Minimum Expectations, 2000

	2000 Spring	2000 Summer	2000 Fall
White	84	85	84
Hispanic	58	69	61
African Am.	59	63	56
Economically Disadvantaged	55	66	59

Tables C1 and C2 presented data on the U.S. History End-of-Course exams for the Spring, Summer, and Fall administrations for the 1999 and 2000 school years, respectively. Without "teaching to the test" and the assistance of a large testing industry, scores have essentially not changed at all, as gaps between White student scores and minority and economically disadvantaged student scores remained consistently large. Equity is clearly not reflected in the U.S. History End-of-Course exam results.

Tables C3

Biology Percent Meeting Minimum Expectations, 1999

	1999 Spring	1999 Summer	1999 Fall
White	89	85	91
Hispanic	64	56	70
African Am.	67	53	65
Economically Disadvantaged	62	51	69

Tables C4

Biology Percent Meeting Minimum Expectations, 2000

	2000 Spring	2000 Summer	2000 Fall
White	91	86	92
Hispanic	69	62	68
African Am.	70	57	69
Economically Disadvantaged	68	59	67

Tables C3 and C4 presented data on the Biology End-of-Course exams for the Spring, Summer, and Fall administrations for the 1999 and 2000 school years, respectively. Without "teaching to the test" and the assistance of a large testing industry, scores have essentially not changed at all, as gaps between White student scores and minority and economically disadvantaged student scores remained consistently large. Equity is clearly not reflected in the Biology End-of-Course exam results.

Tables C5

Algebra I Percent Meeting Minimum Expectations, 1999

	1999 Spring	1999 Summer	1999 Fall
White	58	28	49
Hispanic	32	17	27
African Am.	25	14	21
Economically Disadvantaged	31	16	26

Tables C6

Algebra I Percent Meeting Minimum Expectations, 2000

	2000 Spring	2000 Summer	2000 Fall
White	57	38	55
Hispanic	34	18	30
African Am.	27	15	28
Economically Disadvantaged	32	17	31

Tables C5 and C6 presented data on the Algebra End-of-Course exams for the Spring, Summer, and Fall administrations for the 1999 and 2000 school years, respectively. Without "teaching to the test" and the assistance of a large testing industry, scores have essentially not changed at all, as gaps between White student scores and minority and economically disadvantaged student scores remained consistently large. Equity is clearly not reflected in the Algebra End-of-Course exam results.

Tables C7

English II Percent Meeting Minimum Expectations, 1999

	1999 Spring	1999 Summer	1999 Fall
White	84	63	84
Hispanic	63	55	69
African Am.	60	42	66
Economically Disadvantaged	61	48	67

Tables C8

English II Percent Meeting Minimum Expectations, 2000

	2000 Spring	2000 Summer	2000 Fall
White	84	53	84
Hispanic	72	52	72
African Am.	69	40	69
Economically Disadvantaged	69	49	70

Tables C7 and C8 presented data on the English II End-of-Course exams for the Spring, Summer, and Fall administrations for the 1999 and 2000 school years, respectively. Without "teaching to the test" and the assistance of a large testing industry, scores have essentially not changed at all, as gaps between White student scores and minority and economically disadvantaged student scores remained consistently large. Equity is clearly not reflected in the English II End-of-Course exam results.