Study I. The ESEA Title IV-C Project: Developing Critical and Creative Thinking Through Chess

The ESEA Title IV-C federally funded research project was approved for three years (1979-82). It was extended for one school year (82-83) at local expense for a combined total of four years. The primary goal of the study was to provide challenging experiences that would stimulate the development of critical and creative thinking.

The Title IV-C project was an investigation of students identified as mentally gifted with an IQ of 130 or above. Students in the nonchess groups exceeded those in the chess group in Mean IQ by 2.3 points, which is not significantly different. All participants were students in the Bradford Area School District in grades 7 through 9. The individuals sampled in this study could not be randomly assigned to groups because the students' individualized education plans prescribed activities based on interests.

The primary independent variables reviewed in this summary are the chess treatment, the computer treatment, and all nonchess treatments combined. Each group met once a week for 32 weeks in the gifted resource room at Bradford Area High School to pursue its interest area under the leadership of the Coordinator of Secondary Gifted Education (Robert Ferguson). Most groups spent a total of 60-64 hours pursuing their preferred activity.

The dependent variables were the differences in the means of the posttests from the pretests. Data were collected from the *Watson-Glaser Critical Thinking Appraisal* and the *Torrance Tests of Creative Thinking*. The chi square test and the t test were applied to determine the level of statistical significance.

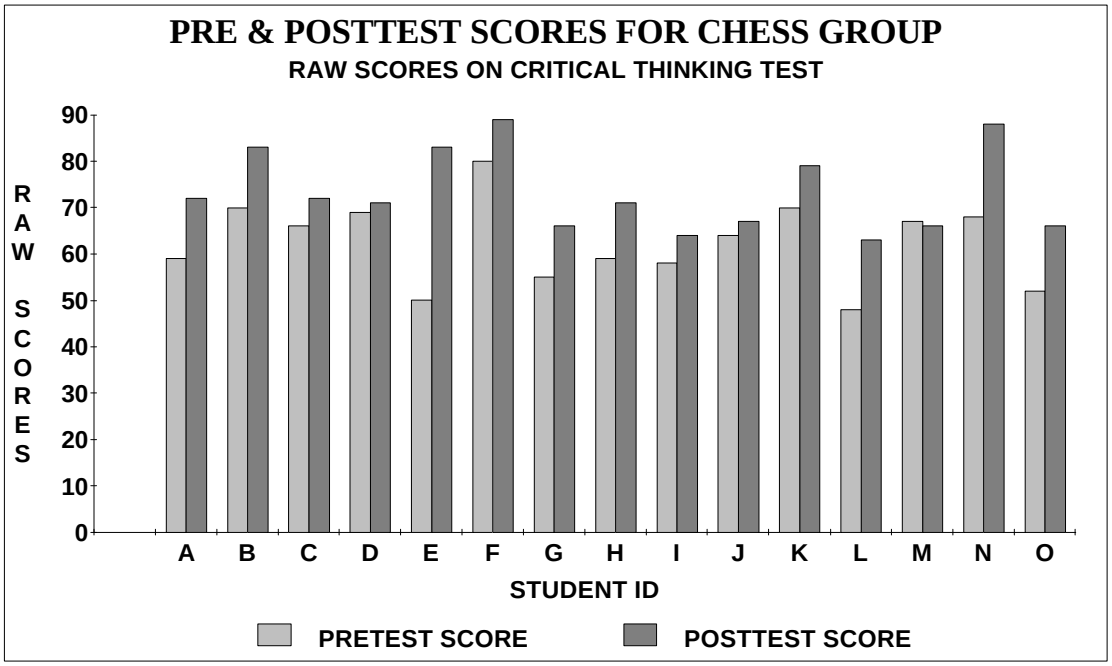

FIGURE 1. A comparison of the pre and posttest scores for the chess group on the *Critical Thinking Appraisal*

Results and Data Analysis

It is important to note that ***all*** scores reported for the *Watson-Glaser Critical Thinking Appraisal* (*WCTA* or *CTA*) are equivalent raw scores. Watson and Glaser (1964, p. 8) used a procedure called equi-percentile equating to determine equivalent raw scores. These scores were all based on norms for high school students and beyond. Since this study was testing junior high level students and no norms exist for seventh and eighth graders, the project director was forced to use the high school norms and equivalent raw scores. In some cases pupils in the study actually scored more correct answers on the posttest than on the pretest and still showed a loss due to the equivalent raw score procedure.

Inspection of the pre and posttest results in the figure on page one shows that all but one chessplayer demonstrated gains in raw scores. The average annual increase in equivalent raw scores for the chess group was 10.53.

The average annual increase in percentile score for the chess group was 17.3%. Nationally, students who take this test at yearly intervals do not show a gain in percentile ranking. This comparison shows that the Bradford chess group significantly outperformed the average student in the country four years in a row!

A 50% score means the student is average in the country for that grade level on the *Watson-Glaser Critical Thinking Appraisal*. A score of 99% means the student is one of the best critical thinkers in that grade for the skills assessed by the *Watson-Glaser Critical Thinking Appraisal*. A Student who scores in the 50th percentile in 1979 and who continues to perform in average fashion, will score in the 50th percentile in 1980. An increased percentile score indicates an above average performance.

Percentile scores are inappropriate for statistical analysis. In order to have an appropriate metric, the percentile scores were converted to ***equivalent*** raw scores.

The t test was used to test statistical significance of the gains on the *Watson-Glaser Critical Thinking Appraisal*. The t test measures the quantity of the gain to assess whether it is significant.

TABLE 1. Dependent t test evaluating significance of gains on the *Critical Thinking Appraisal* (*CTA*) by chessplayers

VARIABLE	**NUMBER**	**MEAN**
Pretest Scores	15	62.80
Posttest Scores	15	73.33
Difference	**Standard Error**	**t value**
10.53	2.2	4.786

Significant beyond the .001 level

Table 1 on the preceding page demonstrates that the chessplayers achieved a very significant gain ($p < .001$) from the pretest to the posttest in critical thinking skills as measured by the *Watson-Glaser Critical Thinking Appraisal*. The level of significance tells us that there is less than one possibility in a thousand that this result could have occurred by chance.

Just as the dependent t test illustrated above is extremely significant, so too is the independent t test illustrated in Table 2, which indicates that the chess group's performance is notably superior to that of the nonchess group's. The results, which are statistically significant at the .001 level, are shown in Table 2.

TABLE 2. Independent t test evaluating significance of difference on the *Watson-Glaser Critical Thinking Appraisal* between the chessplayers and nonchessplayers

VARIABLE	**NUMBER**	**MEAN**
Nonchess Group Gains	79	1.86
Chess Group Gains	15	10.53
Difference	**Standard Error**	**t value**
8.67	2.4	3.61

Significant at the .001 level

The data were also evaluated using a nonparametric, or distribution-free, test of significance. For Study I, the chi square test of statistical significance was used to evaluate the gains/losses on the *Watson-Glaser Critical Thinking Appraisal*. The chi square test evaluates the significance of the number of chessplayers demonstrating gains on the *CTA* compared to the number of non-chessplayers showing gains. Because the chi square test is nonparametric, it is insensitive to the size of gains; it considers a gain of one point in the same manner as a gain of 30 points or 100 points.

The chess group was compared to the nonchess group, the computer group, and the nonparticipants. The chi square test results ranged from marginally significant at .072 to very significant at .002. A complete listing of the chi square test results may be found in Table 3 on the next page.

Particular attention should be given to the results comparing the gains of the eighth graders on the *CTA*. These are perhaps the most significant of all the critical thinking results because eighth graders comprised 46% of the total number of students participating in the project. Out of a total of ninety-four pupils who completed both the pre and posttests, forty-three were eighth graders. Because this was the largest grade sample, it becomes more statistically important and increases our level of confidence in the results.

TABLE 3. Statistical summary for *CTA*

TABLES	t Test $p<$	Chi Square χ^2 $p<$
MALES & FEMALES COMBINED:		
Chess Group	**0.001**	
Chess vs. Nonchess	**0.001**	**0.008**
Chess vs. Computer	**0.003**	**0.008**
Chess vs. Nonparticipants	**0.025**	**0.002**
MALES:		
Chess Group	**0.003**	
Chess vs. Nonchess	0.072	0.056
Chess vs. Computer	**0.017**	**0.023**
FEMALES:		
Chess Group	**0.043**	
Chess vs. Nonchess	0.085	0.071
Chess vs. Computer	0.195	0.104
ALL 8TH GRADERS:		
Chess Group	**0.003**	
Chess vs. Nonchess	**0.006**	**0.009**
Chess vs. Computer	0.142	**0.05**

In a Fidelity Electronics' article entitled "The Minds of Tomorrow" (1993), the company states: "In light of chess playing's ability to shape future minds, schools all across the United States view chess as a powerful educational tool. Thousands of pre-teens and teens understand that chess coheres the mind to anticipate, make decisions, and react in a way no other game can."

Dr. R.J. Topping (1988), the Coordinator of the Gifted/Talented Programs for the White Plains Public Schools, agrees with Fidelity and states:

> Chess is an integral part of the logic and creative problem-solving segment of our More Able Student curriculum. It cultivates critical thinking skills in our students, enhancing their personal growth and academic learning. We encourage other school systems to consider offering their students experiences in this dynamic content area (Chess in the Schools, 1988, p. 3).

Many teachers use chess as a vehicle to teach critical thinking skills. They stress to students that learning *how* to think is more important than learning the solution to a specific problem. Through chess, pupils learn how to invent creative solutions to problems. They learn how to analyze a situation by focusing on the important factors. Chess is effective because it is self-motivating. The game is intrinsically fascinating, and the goals of attack and defense, climaxing

in checkmate, motivate young people to delve deep into their mental resources (Chess in the Schools, 1988, p. 2).

The next portion of the results and data analysis summary reviews the different aspects of creativity tested in this research: fluency, flexibility, and originality.

Verbal fluency is an individual's ability to generate a large number of ideas with words. Chessplayers often have a running dialogue within their minds reviewing the checklist for important strategic and tactical factors or mentally calculating: "If I go there, then he'll move . . ."

Flexibility represents a person's ability to produce a variety of types of ideas, to shift from one approach to another, or to use a variety of strategies. Originality is skill at producing ideas that are different from the obvious.

Torrance (1974) defined creative thinking as: "a process of becoming sensitive to problems, deficiencies, gaps in knowledge, missing elements, disharmonies, and so on; identifying the difficulty; searching for solutions, making guesses, or formulating hypotheses about the deficiencies: testing and retesting these hypotheses and possibly modifying and retesting them; and finally communicating the results."

It is important to note that ***all*** scores reported for the *Torrance Tests of Creative Thinking* are standard T-scores. All raw scores were converted in accordance with the recommendations in the *Torrance Tests of Creative Thinking* Norms-Technical Manual (1974, pp. 48, 56). These scores were all based on creative thinking norms established for junior high school students.

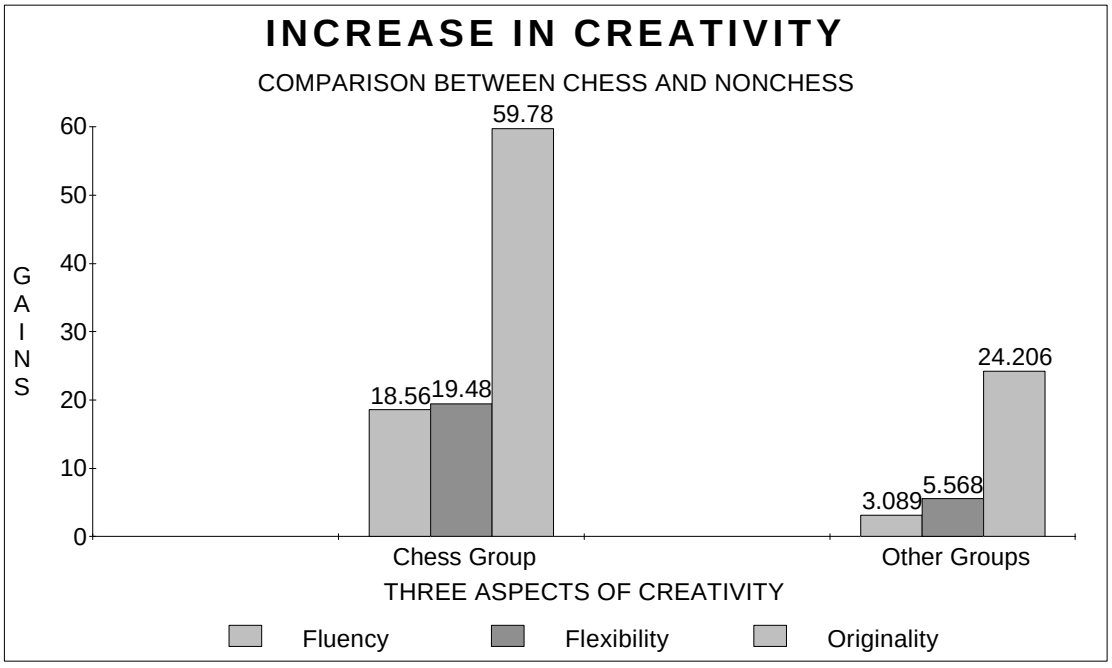

FIGURE 2. A comparison of the chess group gains to the nonchess group gains

Creativity is a major aspect of chess at the master level, but can chess influence creativity at the amateur level? Summary Table 4 sheds some light on this question. It would appear from the data collected and the statistical test results listed in the table below that there can be little doubt that chess does enhance creativity in gifted adolescents. Dr. Stephen Schiff's claim that creativity can be taught through the art of chess has been confirmed.

While the entire chess group made superior gains over the other groups in all three areas, the aspect that demonstrated the most significant growth was originality. It should be noted that several researchers have found that gains in originality are usual for those receiving creativity training, whereas gains in fluency are often slight or nonexistent. The fact that the chess group's gains in fluency were significant beyond the .05 level when compared to the national norms is an important discovery.

It appears that chess is superior to many currently used programs for developing creative thinking and, therefore, could logically be included in a differentiated program for mentally gifted students.

TABLE 4. Statistical summary of t tests on Creativity

TABLES	FLUENCY	FLEXIBILITY	ORIGINALITY
	p<	*p*<	*p*<
MALES & FEMALES COMBINED:			
Dependent Chess	0.077	**0.024**	**0.01**
Population Mean Chess vs. Norms	**0.039**	**0.002**	**0.001**
Independent Chess vs. Nonchess	**0.049**	**0.05**	**0.018**
Independent Chess vs. Computer	**0.038**	0.08	**0.022**
MALES:			
Dependent Chess	0.142	**0.03**	**0.016**
Population Mean Chess vs. Norms	0.07	**0.008**	**0.003**
Independent Chess vs. Nonchess	**0.039**	**0.007**	**0.002**
Independent Chess vs. Computer	0.076	**0.018**	**0.007**
ALL 8TH GRADERS:			
Dependent Chess	0.32	0.088	**0.018**
Population Mean Chess vs. Norms	0.171	**0.037**	**0.019**
Independent Chess vs. Nonchess	0.305	0.061	**0.009**
Independent Chess vs. Computer	0.606	0.12	**0.027**
ALL 8TH GRADE MALES:			
Dependent Chess	0.32	0.088	**0.018**
Population Mean Chess vs. Norms	0.171	**0.037**	**0.019**
Independent Chess vs. Nonchess	0.383	**0.014**	**0.006**
Independent Chess vs. Computer	0.561	0.107	**0.02**

Conclusions

It is evident from the above tables and data that chess had a definite impact on developing both critical and creative thinking skills. Because the sample size of the treatment group was only 15 students, the author would encourage replication of this study using a larger *N*.

It was also evident that there were significant gains in the participants' chess skills. Six of the pupils involved in this study participated in the annual Pennsylvania State Scholastic Championship beginning in 1980. Three of those six excelled. Two of the boys became candidate masters and one of the girls made the top 50 list for all women chessplayers in the United States.

The project director concurs wholeheartedly with Dr. Stephen M. Schiff (1991), who wrote: ". . . the study of chess is one of the most critically important additions to the curriculum that schools can offer to our pre-adolescent gifted and talented student population." Based on the results of Study I and others, this researcher ***urges*** the inclusion of chess in the curriculum to augment the skills of the mentally gifted.

The *USA Junior Chess Olympics Training Program* used in each of Ferguson's studies undeniably demonstrated effectiveness in bringing about the desired changes in the participating students. This author would strongly recommend the adoption or adaptation of the *USA Junior Chess Olympics Training Program* within the school curriculum throughout the country.

For Those Who Haven't Studied Statistics

"Tradition holds that the level of significance must be expressed as *the probability that a true null hypothesis is being rejected*. That means that the ***lower*** the significance level, the ***higher*** is our confidence that the effect we have observed is real." (Phillips, Statistical Thinking: A Structural Approach, p. 85, 1973)

Some researchers hold that a probability of **.1** (10%) is significant; however, in this study and Ferguson's other research, a ***significant*** difference is equal to or less than **.05** (often written $p<.05$). A ***very significant*** difference is one for which the probability of having occurred by sampling error is less than 1% (**.01**) and is frequently written $p<.01$. In the statistical summary (Table 4), the ***significant*** and ***very significant*** levels have been **bolded**.

For Additional Information

The preceding material is a brief synopsis of the information found in a paper (200+ pages) by Robert Ferguson entitled *Teaching the Fourth "R" (Reflective Reasoning) Through Chess*. If you would like a more comprehensive review of this research and his other studies, send a check for ***$39.95*** payable to the American Chess School at the address below. ***All profits from the sale of this publication are used to support chess in the schools***.

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