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Modern Theories of Intelligence Applied to Assessment of Abilities, Instructional Design, and Knowledge-based Assessment

Robert J. Sternberg
Elena L. Grigorenko
Bruce Torff
Linda Jarvin
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ABSTRACT

This monograph reports findings from three intervention studies in which the triarchic theory of intelligence was infused into the curricula. Two studies focus on middle school and one study on high school. Teachers were trained in, and asked to implement, either triarchically enhanced curriculum (experimental groups) or were trained in mnemonic strategies and asked to implement their regular curriculum (control groups). Sample curriculum lessons are included in the text. In all three studies, students benefited from triarchic instruction. The present work shows that students also benefited without regard to the grade level or subject matter tested.

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EXECUTIVE SUMMARY

This monograph describes a set of studies looking at the effect of infusing principles of triarchic teaching into the curriculum. The goal of the three studies reported is to test the efficacy at the primary and secondary levels of instruction based on the triarchic theory of intelligence (Sternberg, 1985, 1997, 1999) that is infused into already existing curricula. According to the triarchic theory, human intelligence comprises three main aspects: analytical, creative, and practical. Infused into instruction and assessment, analytical tasks involve analyzing, judging, evaluating, comparing and contrasting, and critiquing; creative tasks involve creating, inventing, discovering, imagining, and supposing; and practical tasks involve implementing, using, applying, and seeking relevance (Sternberg, 1994a, 1994b). More conventional memory-based instruction involves memorizing, remembering, recalling, recognizing, and repeating.

The first study involved a regular middle school curriculum, the second study a middle school summer program, and the last study addressed high school students. In the first study, we developed, implemented, and evaluated a triarchic enrichment of an existing reading curriculum at the fifth grade level. We modified the existing reading program of the New Haven Public School District so that its content would be preserved but the methods of teaching could be enriched. The main question was whether we could improve students' reading skills by enrichment of teaching methods within the context of an extant basal-based reading program. In this program, experimental group teachers taught the subject matter they would have taught anyway, but they taught it triarchically. Control group teachers taught in their normal manner with enhanced emphasis on the use of mnemonics and other strategies for enhancement of memory for material that has been learned. Thus, enhancement in the experimental groups was in terms of triarchic thinking and in control groups was in terms of memory. The program was implemented for two consecutive years. Data analyses showed that training had a significant impact on performance scores over time whereby students taught triarchically profit more over time from instruction than do students not taught triarchically. In addition, all variables in the equation were found to impact the performance scores. Of most importance was the impact of the standardized reading achievement indicator (*DRP*). This variable predicted both (a) the levels of performance on the task (so that children with higher *DRP* scores demonstrated better performance) and (b) the susceptibility to the triarchic intervention (children who gained from the program the most tended to demonstrated lower *DRP* scores).

The main objective of the second study was to develop a stand-alone triarchic reading curriculum for an academic summer program in a low SES urban school district. This program was developed for two fiction books recommended as supplementary reading in upper middle school grades. The program's goals were to select a high-achieving group of students from an urban school district, assess the students' reading skills using a pretest based on grade-appropriate reading material (developed on the basis of commercial textbooks for seventh grade), randomly divide the group into two subgroups, teach one group triarchically for a duration of 6 weeks, and then reassess reading skills in the whole group. In other words, the main purpose of this study was to investigate whether a 6-week triarchic reading program can significantly improve reading performance and what the dynamics of this improvement were. Data analyses showed that in this study we generally replicated the pattern of findings reported in Study 1: The triarchic group benefited significantly more over time from instruction than did the control group.

The main objective of the third study was to investigate ways and benefits of incorporating triarchic instruction into teaching in a variety of subject areas. This study was conducted in three public high schools in urban districts in the subjects of mathematics, physical sciences, social sciences, English, history, foreign languages, and the arts. Having observed the benefits of triarchic instruction in one subject area, can we expect to see comparable gains in comprehension and vocabulary skills applied to multiple subject matter areas? Data analyses showed that training has a significant impact on the performance scores. Specifically, students who were taught through triarchic methodologies benefited more from instruction than did students who were taught in more conventional ways.

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Table of Contents

Table of Contents (continued)

Table of Contents (continued)

List of Tables

List of Figures

Modern Theories of Intelligence Applied to Assessment of Abilities, Instructional Design, and Knowledge-based Assessment

Robert J. Sternberg
Elena L. Grigorenko
Bruce Torff
Linda Jarvin
Yale University
New Haven, Connecticut

Intervention Study I—Teaching Triarchically Improves School Achievement

Robert J. Sternberg, Bruce Torff, & Elena L. Grigorenko

Introduction

Ever since Binet and Simon (1916) proposed their concept of "mental orthopedics," some theorists of intelligence have sought not just to understand intelligence nor to measure it, but to use theory to improve learning and perhaps even the intellectual abilities underlying learning as well. Ideally, instruction and assessment based on a theory of intelligence would enhance learning and the performance outcomes associated with it.

Although many instructional programs based on cognitive theory have been suggested (see, e.g., Baron & Sternberg, 1987; Bransford & Stein, 1993; Costa, 1985; Feuerstein, 1980; Halpern, 1996; Nickerson, 1994, Nickerson, Perkins, & Smith, 1985; Sternberg & Bhana, 1986), relatively few have been based explicitly on theories of intelligence. Some, like the Structure of the Intellect (SOI) program of Meeker (1969), which is based on the theory of Guilford (1967), or the Intelligence Applied program of Sternberg (1986), which is based on Sternberg's (1985) own theory, have been separate programs designed to use aspects of a theory of intelligence to improve thinking skills. But many educators have turned to the question of how to infuse such a theory into already existing instructional programs (e.g., Swartz, 1987).

Perhaps the most well-known attempts are based on the theory of multiple intelligences proposed by Gardner (1983, 1993). These attempts have met with mixed success (Callahan, Tomlinson, Moon, Tomchin, & Plucker, 1995), although many of the evaluations are informal or uncontrolled so that it is hard to know exactly what the outcomes have been (Gardner, 1993, 1995a). As with any theory, there is a potential danger in any of these programs that the infusion will be less than true to the vision of the theorist (Gardner, 1995a), so it becomes even more difficult to know whether the theory leads to success when infused into classroom instruction and assessment.

Although one might expect teachers to flock to the use of such programs, in fact, teachers are often reluctant because of the specter of the need to prepare students for the various kinds of mastery or other achievement tests the students will need to take. Teachers sometimes believe that teaching for thinking will undermine students' performance on these tests, which, they believe, measure primarily mastery of facts rather than higher order thinking with these facts (Sternberg, 1996; Sternberg & Spear-Swerling, 1996). Moreover, teachers may be skeptical even that the program will, in fact, produce superior knowledge or ability to use knowledge in their students, regardless of how these outcomes are measured.

The goal of the two studies reported is to test the efficacy at the primary and secondary levels of instruction based on the triarchic theory of intelligence (Sternberg, 1985) that is infused into already existing curricula. According to the triarchic theory (Sternberg, 1985), human intelligence comprises three main aspects: analytical, creative, and practical. Infused into instruction and assessment, analytical tasks involve analyzing, judging, evaluating, comparing and contrasting, and critiquing; creative tasks involve creating, inventing, discovering, imagining, and supposing; and practical tasks involve implementing, using, applying, and seeking relevance (Sternberg, 1994a, 1994b). More conventional memory-based instruction involves memorizing, remembering, recalling, recognizing, and repeating.

In earlier work, we attempted to infuse a portion of this theory (the practical part) into the curriculum, combining it with Gardner's theory of multiple intelligences (Gardner, Krechevsky, Sternberg, & Okagaki, 1994; Sternberg, Okagaki, & Jackson, 1990; Williams, Blythe, White, Sternberg, & Gardner, 1996), but the studies described here represent an infusion of all aspects of the theory.

In more recent work (Sternberg & Clinkenbeard, 1995; Sternberg, Ferrari, Clinkenbeard, & Grigorenko, 1996), we have infused the triarchic theory into instruction and assessment in psychology of high school students selected for a special summer program at Yale. Students were chosen to represent particular ability patterns, and then were given instruction that either more closely or more distantly matched their patterns of abilities. All students were assessed for achievement in terms of multiple-choice memory tests, as well as for analytical, creative, and practical performances. We found that students who were better matched to instruction in terms of their patterns of abilities outperformed those students who were more poorly matched.

The basic design of the two studies described here involves groups receiving instruction in existing curriculum units that is either enhanced via the triarchic theory or that is not. Two control conditions are used for evaluation of the efficacy of the instruction. The first is a traditional instruction group, in which students receive exactly the instruction that they would receive without the experimental intervention. The second and stronger control group is one that receives instruction enhanced by the infusion of critical (analytical) thinking skills, which represent the most frequently used kind of infusion, but which represent only part of what the triarchic theory would suggest needs ideally to be infused into the curriculum.

To ensure, to the best of our ability, an adequate test of the model, we used both memory-based multiple-choice assessments, which were already part of the existing curriculum, and our own performance-based assessments, which measured achievement in terms of the utilization of analytical, creative, and practical abilities. Thus, it would be possible to determine whether triarchic instruction improved performance on the performance assessments of achievement following from the theory, and even on memory-based assessments that did not follow directly from the theory but that were already being used as part of the assessment program for the courses being taught. At the primary level, we also used self-report assessments.

We predicted that triarchic instruction would improve achievement—both on memory-based multiple-choice items and on analytically, creatively, and practically based performance assessments. There were two reasons for this prediction, following from the triarchic theory (Sternberg, 1996; Sternberg & Spear-Swerling, 1996). First, triarchic instruction should enable students to encode the information to be learned in three different ways (analytically, creatively, and practically), as well as for memory. The multiple encodings of information should improve learning. Using this approach, students think to learn, and simultaneously learn to think. Second, triarchic instruction should enable students to capitalize on their strengths and to compensate for or correct their weaknesses, a key aspect of triarchic instruction, as well as of all instruction based on notions of aptitude-treatment interaction (Cronbach & Snow, 1977). In other words, there should be at least some instruction that would be compatible with almost all students' strengths, enabling the students to bring these strengths to bear on the work at hand. At the same time, at least some of the instruction would probably not correspond to students' strengths, encouraging the students to develop modes of compensation for and correction of weaknesses. Instruction that enables students to capitalize on strengths is also likely to motivate students more than instruction that does not allow such capitalization.

The basic strategy for our studies was to (a) divide students into three groups, using standardized ability-measures to analyze the comparability of the groups; (b) provide different instructional treatments, corresponding to the three types of instruction discussed above (triarchic, critical thinking, and traditional); and (c) administer knowledge-based assessment measures, to examine differences that might obtain in outcomes generated by the three instructional treatments. Hence, each student took a standardized ability test, received training over an extended period, and then was given a battery of knowledge-based assessment instruments. This protocol was conducted with two groups of students and teachers, one in a primary school setting and the other in a middle school setting.

The Primary School Project Study

Method

Participants

In the primary school project, the participants included 213 third grade students (106 boys and 107 girls) in two elementary schools in Raleigh, NC. Both schools serve a diverse population of primarily lower socioeconomic status (SES) students, including large groups of African American, Hispanic, and Asian students. Both schools are designated by the school district as "gifted and talented magnet" schools, but they serve both gifted and nongifted populations. A total of nine classes of 20-25 students participated in the research. These classes were taught by nine experienced teachers who were certified to teach third grade in North Carolina.

Ability Testing

Participating students took a standardized test of cognitive abilities, the Otis-Lennon Intelligence Scales, as part of a district-wide testing program for identification of giftedness. In the results section below we use the Otis-Lennon scores as a covariate with the effects of different instructional treatments.

Instructional Treatments

Prior to the intervention, participating teachers were divided into three groups, one for each form of instructional treatment. The teachers then received extensive training programs focusing on techniques for implementation of the appropriate instructional strategies. Each of the training programs comprised a series of workshops that included (a) descriptions and models of appropriate teaching strategies, and (b) opportunities for teachers to create lesson plans and classroom activities and to receive feedback on their work. Each workshop included techniques for infusing the appropriate strategy into all aspects of instruction, including lecture, discussion, collaborative-learning groups, and individual assignments.

There were three training programs in all, one for each instructional treatment. In the triarchic group, the teachers participated in workshops devoted to techniques for using and strengthening analytical, creative, and practical skills in the classroom. The critical thinking group focused exclusively on analytical abilities. The traditional instruction group participated in workshops focusing on an irrelevant topic—procedures for portfolio assessment. None of the teachers collected portfolios during the intervention.

Because primary school teachers have only one class at a time, each teacher was trained only for the instructional treatment to which he or she was assigned. The five teachers at School A, where the triarchic and critical thinking groups were located, were divided between the triarchic and critical thinking groups. All teachers at School B,

which functioned only as a control school in the Primary School Project Study, were assigned to the traditional instruction group. The separation of the traditional control group by school was intended to minimize the cross-contamination that can result within a school when experimental group teachers interact with control group teachers.

During the intervention, the students received an instructional unit on the topic of "communities"—a social-studies unit required for third grade students in North Carolina. The unit centered on four curriculum objectives published in the Curriculum Guide given to teachers by the North Carolina Department of Education. Curriculum objectives for the unit included: (a) citizenship; (b) similarities and differences between individuals, families, and communities; (c) concepts of authority, responsibility, and justice; and (d) relationships between people and their governments. No text was used for the unit—materials for the courses were developed individually by the teachers. The intervention took place for 10 weeks, 4 days per week, 45 minutes per day, for a total of 30 hours of instruction.

A total of nine sections of the unit were taught at the two schools. Of the five sections at School A, three were given triarchic instruction (n=74) and two received critical thinking instruction (n=45). At School B, all four sections received traditional instruction (n=92).

To illustrate the three different instructional treatments, consider three ways in which a third grade unit on public services (e.g., fire, police) can be taught. The approach taken in traditional instruction is to have children memorize the names and functions of the various public services. In critical thinking instruction, an additional analytical effort is undertaken, perhaps one assigning students to compare and contrast the different services and evaluate which ones to keep in case of a budget crisis. In the triarchic group, creative and practical skills are used as well as analytical ones; students might be assigned to come up with their own public service, to describe its means and ends, and to compare this new public service with conventional ones.

During the intervention, the students received instruction that reflected the differences among these three instructional treatments. A typical activity in the traditional instruction group emphasized memory abilities:

> A police officer came to visit the class. He answered questions from the students and talked about what police officers do. He also talked about the equipment police offers use and how a person goes about becoming a police officer. After he left, each student wrote a letter thanking him and describing what [the student] learned during his visit.

In the critical thinking group, the teachers designed and implemented activities that encouraged students to engage in analytical reasoning:

> Class discussion concerning authority figures: each student records information on a sheet with three columns. At the top of each column is a symbol for the

following: USA/President, NC/Governor, and Raleigh/Mayor. The students take notes in each column as a range of issues are discussed (e.g., comparative powers, privileges, responsibilities).

Analytical activities as such were also used in the triarchic-instruction group, which focused as well on activities drawing on creative and practical skills:

> The students invented their own government agency. They had to decide what service to provide, give it a name, tell why it's important, and why the government should pay for it. Then [students were asked to] make an advertisement for [the invented government agency]. [The class] shared the agencies for the rest of the class time. (Creative)

> The students were given a problem situation of littering in the community. They brainstormed consequences that could be used in that situation. The teacher listed them on the board. Students then decided which consequences were appropriate (fair versus unfair). Then we tied our "make believe" littering-in-the-community problem to our real-life problem of litter on the school grounds. In groups, the students brainstormed possible solutions to the problem. They regrouped to pick the best solution and discuss consequences for future "offenders." They came up with a school-wide litter pick-up day for each grade level. (Practical)

Knowledge-based Assessment

Following the intervention, students completed a battery of assessment instruments designed to capture how much they learned and how they were able to use that knowledge. Three types of assessments were employed: (a) a total of 16 multiple-choice items; (b) essay items designed to capture analytical, creative, and practical abilities; and (c) performance assessments (assignments relying less heavily on students' writing skills, such as drawing a map) also implemented to measure analytical, creative, and practical abilities.

The battery of assessments included three essay items—an analytical one, a creative one, and a practical one—that required students to compose paragraph-long responses to the following prompts:

> *Essay Item 1* (Analytical)
>
> Select one of the positions of authority on the list below. Write a page explaining what a person in this position does. Say why the position is needed and why it is a position of authority. Describe its privileges and limitations.
>
> - Governor of North Carolina
> - Mayor of Raleigh
> - Animal control officer (dog catcher)
> - Judge
> - Internal Revenue Service worker (tax collector)

Essay Item 2 (Creative)

Imagine a place where no one tried to be a good citizen—where no one followed most of the rules at school or in the community. Write a story about a third grader's visit to this place. Discuss several different things that you might see during your visit. Why do you think these things might happen? Be creative with your answer!

Essay Item 3 (Practical)

A group of 8-year-old students from England is going to visit. You are in charge of teaching them about the different kinds of governmental services that we have in Raleigh. You want the visitors to have a general understanding of how Raleigh's system of government works. Write a paragraph describing what you will do and why. What do you want the visitors to learn, and why? What methods of teaching will work best?

In addition, the assessment battery included performance items—again, in terms of analytic, creative, and practical abilities—which are less dependent on students' writing skills:

Performance Item 1 (Analytical)

Some people believe that taxes ought to be lowered. Other people disagree; they believe that the current level of taxation is appropriate.

Task 1: Make a list of the *advantages* of lowering taxes. Make a second list of the *disadvantages* of lowering taxes.

Task 2: Write a paragraph stating your recommendation whether or not taxes should be lowered. Be sure to say *why* you believe taxes should (or should not) be lowered.

Performance Item 2 (Creative)

Design an "ideal community" with different kinds of organizations that serve the public. What organizations would your ideal community have? Why are the services provided by these organizations needed? Draw a map or a picture of your community. Be sure to describe the services you want your ideal community to have; also, say *why* you want to include them. Be creative!

Performance Item 3 (Practical)

Your school is holding an election to choose a class president, and you are the new Election Commissioner. Your job is to organize the election so that all the students have a chance to vote.

Below is a list of steps you might take to make the election a success. You don't have time to do them all, so *pick the five most important steps* to take. Place an "x" next to the steps you think are most important. You can pick only five steps. For each step you have selected, write a few words saying *why* you selected it. Don't write anything about the steps you choose NOT to take.

Why did you select this step?
___have ballots printed_____
___become one of the candidates_____
___count the votes after the polls close_____
___tell students whom to vote for_____
___create political parties among the students_____
___make sure that the election is fair_____
___have a debate between the candidates_____
___make sure a polling place is available_____
___decide who to vote for_____
___discuss the important issues of the election_____
___publicize the date and time of the election_____

Self-assessments

Students were asked to respond to three self-assessment questions: (a) How much did you like the course? (b) How much do you think you learned [in the course]? (c) How well do you think you did [in the course]? Responses were made on a 5-point Likert scale.

Data Analysis

Following the intervention, the performance assessments were scored by three raters—undergraduate students majoring in psychology who had no knowledge of the research design or hypothesis. The raters used a five-point Likert-type scale to rate the overall quality of each of the responses. The raters met frequently for several weeks to tune the rating process and to increase rater-reliability. For the 15 items that required subjective ratings (one item, Performance Item 3, could be scored directly), inter-rater correlations for pairs of raters ranged from .77 to .88. The overall inter-rater correlation of .83 was deemed sufficiently high to provide a reliable assessment of students' responses to the essay items and performance assessments.

Results and Discussion

Outcome Measures

As described in the *Method* section, there were 10 main outcome measures of the Primary School Project Study: a multiple-choice test score, six performance measures (analytical, creative, and practical assessed by the means of a project and an essay), and three students' self-evaluation scores. The corresponding ability measures correlated

significantly (project-essay correlations for analytical, creative, and practical abilities were .25, .56, and .21 [all $p<.000$], respectively), suggesting that derivation of summary scores across the two types of evaluation would be appropriate. This conclusion was supported by the principal-component analyses, where for all three abilities (analytical, creative, and practical) there was only one component, accounting for 60% (for practical) to 78% (for creative) of the variance in the data. The correlations between the summary ability measures and ability scores as assessed by the project and the essay ranged between .78 and .88, demonstrating that both project and essay assessments contributed highly to the summary scores. Consequently, in the following analyses seven outcome measures were utilized: (a) ability measures (analytical, creative, and practical) and the multiple-choice measure and (b) three self-evaluation measures.

Preliminary Analyses

Prior to conducting a series of analyses directed toward testing the hypotheses of the study, we investigated the association between the outcome performance variables (analytical, creative, practical, and multiple choice) and potential covariates, such as gender and scores on the Otis-Lennon ability test. The results revealed no significant differences between performance of boys and girls on any of the dependent measures. Moreover, there was no difference in the pattern of correlations between boys and girls.

In contrast, students' performance was significantly associated with the Otis-Lennon score. The significant correlation coefficients varied between .17 ($p<.02$), for performance-based scores obtained on the project, and .66 ($p<.0001$), for the multiple-choice test. Consequently, even though there were no differences in Otis-Lennon scores between the treatment groups, the patterns of correlation between the outcome measures and the ability measures differed across treatment groups. Thus, although all outcome measures correlated significantly with the Otis-Lennon scores in the triarchic and critical thinking groups, only the multiple-choice performance score correlated with the Otis-Lennon score in the control group. To control the variance in the response to the treatment that might have had differential impact on children with different levels of abilities, the Otis-Lennon score was utilized as a covariate in all subsequent analyses of the four performance measures.

Students' self-assessments neither differentially correlated with the Otis-Lennon ability score nor showed mean differences between the treatment groups. Similarly, we did not find any gender-related differences. Therefore, in these analyses, the ability measure was not included as a covariate in the equation.

Treatment Effect

Multivariate analysis of variance, profile analysis, and pairwise least-square mean comparisons were implemented to evaluate the effect of teaching on students' performance. Two sets of analyses, one for the ability measures and the multiple-choice score and the other for self-evaluation scores, were conducted.

Performance Measures

Three different tests were performed comparing the profiles of scores in the three treatment groups. The least-squares means groups profiles are shown in Figure 1.1. The first test, the so-called flatness test of the group profiles, investigated whether, with groups combined, the differences between various assessments differed from zero (i.e., whether the group profiles were non-horizontal). For this test, Wilks' Lambda was equal to .94 ($F_{(3,207)}$=4.35, p<.01), suggesting that the obtained profiles were not horizontal. The second test, the parallelism test, asked if the difference between, for example, analytical and creative assessments, was the same for students receiving instructions based on the triarchic theory, the critical thinking approach, and traditional teaching. For this test, Wilks' Lambda was equal to .71 ($F_{(6,414)}$=12.90, p<.0001), leading to rejection of the hypothesis of parallelism. In other words, the profiles of Figure 1.1 were not parallel. Finally, the levels test examined differences between the means of the three treatment groups combined over the four evaluations. This analysis demonstrated that, overall, there was a significant difference between treatment groups in average performance on different types of assessments ($F_{(2,209)}$=47.16, p<.0001). The subsequent contrast analysis conducted on the transformed performance variables showed that the triarchic group performed consistently better than either the critical thinking group (the contrast estimate was .75 ± .30) or the traditional group (the contrast estimate was 2.38 ± .25).

A series of subsequent univariate analyses revealed significant F-values for the equations, modeling the sources of variation in the four dependent variables (see Table 1.1).

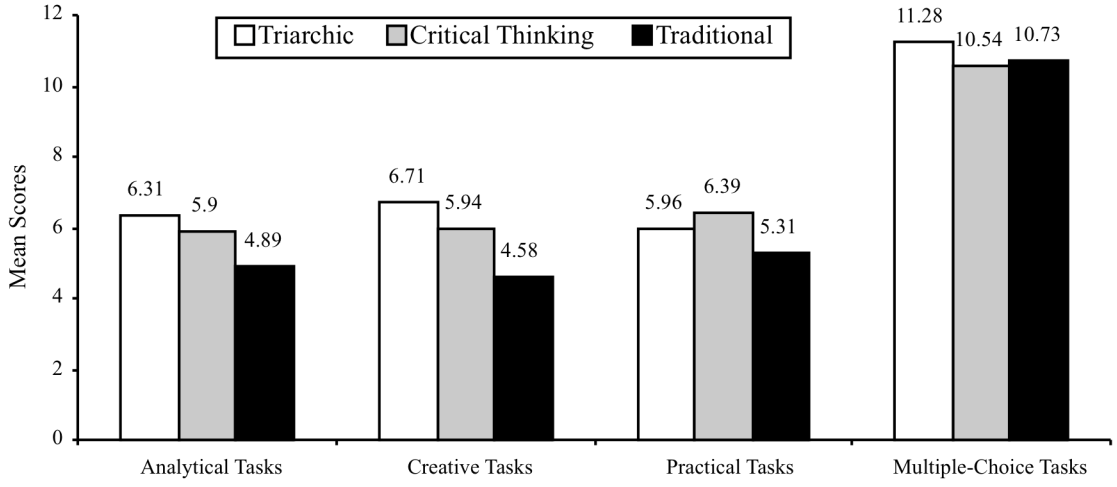


Figure 1.1. Means in the Primary School Project Study: Assessments of achievement.

Table 1.1

Effects in the Primary School Project Study

Assessment	*F*-value	*p*-value	R^2
Analytical	41.24	<.0001	37%
Creative	88.94	<.0001	56%
Practical	18.84	<.0001	21%
Multiple-choice tasks	58.95	<.0001	46%

Specifically, the performance on analytical tasks model was statistically significant ($F_{(3,212)}$=41.24, p<.0001, for the total model; $F_{(2,212)}$=38.03, p<.0001 for the effect of group; and $F_{(2,212)}$=34.34, p<.0001, for the effect of the ability test) and accounted for 37% of the variance. Similarly, the *F*-statistic for the performance on the practical tasks model was significant ($F_{(3,212)}$=18.84, p<.0001, for the total model; $F_{(2,212)}$=15.42, p<.0001 for the effect of group; and $F_{(2,212)}$=22.31, p<.0001 for the effect of the ability test). The R^2 for this model was equal to .21. The model for the performance on creative tasks accounted for 56% of the variance ($F_{(3,212)}$=88.94, p<.0001 for the total model; $F_{(2,212)}$=98.07, p<.0001, for the effect of group; and $F_{(2,212)}$=44.84, p<.0001, for the effect of the ability test). Finally, the multiple-choice model explained 46% of the variance in the children's performance ($F_{(3,212)}$=58.95, p<.0001, for the total model; $F_{(2,212)}$=2.65, p<.07 for the effect of group; and $F_{(2,212)}$=161.16, p<.0001, for the effect of the ability test).

These results were followed up by a series of pairwise comparisons of least-square means (see Figure 1.1). For performance on analytical tasks, the triarchic group performed significantly better than did both the critical thinking (t=2.04, p<.05) and the conventional (t=8.45, p<.0001) groups. Moreover, the critical thinking group performed better than did the conventional group (t=5.23, p<.0001). For performance on practical tasks, there was no significant difference between the triarchic and critical thinking groups, but both groups performed better than did the conventional teaching group (t=3.66, p<.001 and t=5.26, p<.0001 for the critical thinking and conventional groups, respectively). On the creative tasks, students from the triarchic group performed significantly better than did students either in the critical thinking (t=4.14, p<.0001) or the conventional-teaching (t=13.76, p<.0001) groups. Students in the critical thinking group were also better in their creative performance than were those in the conventional teaching group (t=7.66, p<.0001). Finally, the triarchic group students performed better on the multiple-choice test. This difference was statistically significant when compared with the performance of the students whose teaching was based on the critical thinking approach (t=2.07, p<.05) and borderline significant when compared with the performance of the conventional teaching group (t=1.85, p<.06).

Self-assessments

The profiles of least-squares means for the three self-assessment questions are shown in Figure 1.2. As is obvious from Figure 1.2, the profiles were horizontal, so the hypothesis of flatness could not be rejected (Wilks' Lambda=.98, $F_{(2,209)}$=1.66, *ns*). The profiles, however, were not parallel (Wilks' Lambda=.93, $F_{(4,418)}$=3.62, p<.01) and the levels test was significant ($F_{(2,210)}$=38.24, p<.0001). The contrast analyses pointed to the differences between the averaged transformed variables: The students' self-evaluations in the triarchic group were consistently higher than those of the students in both the critical thinking (the contrast estimate was equal to .93 ± .20) and the traditional teaching (the contrast estimate was 1.44 ± .17) groups.

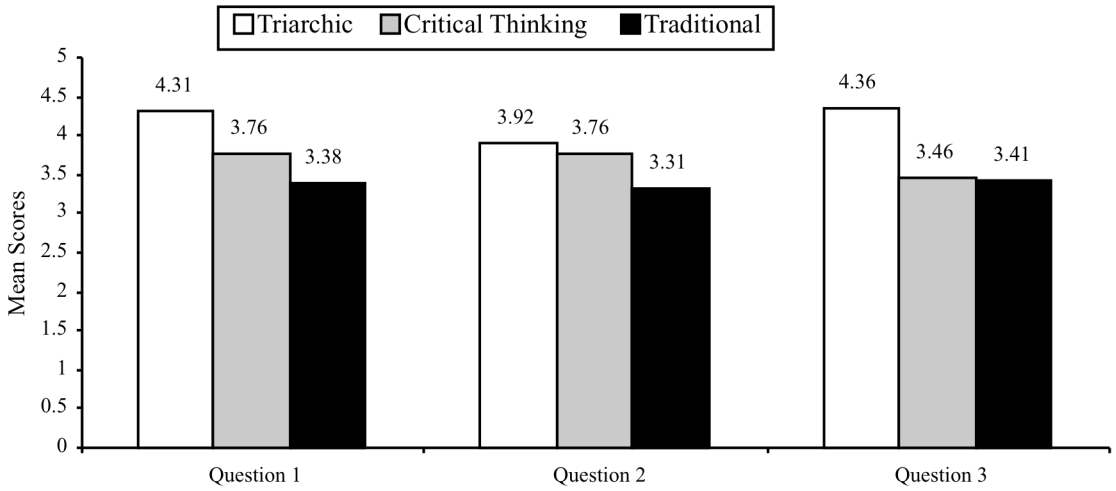


Figure 1.2. Means in the Primary School Project Study: Self-assessments.

A series of subsequent univariate analyses revealed significant *F*-values for all three dependent measures ($F_{(2,212)}$=25.89, p<.0001, R^2=.20, for question 1; $F_{(2,212)}$=8.26, p<.001, R^2=.07, for question 2; and $F_{(2,212)}$=32.31, p<.0001, R^2=.24, for question 3).

A series of pairwise comparisons of least-square means decomposed the observed multivariate effects. For the first question (*How much the students liked the course*), the triarchic group students scored the highest. Their ratings were significantly higher than both the critical thinking group students (t=3.51, p<.001) and the conventional-group students (t=7.19, p<.0001). Critical thinking group students were more satisfied with the course than were the conventional-group students (t=2.56, p<.05). For the second question (*How much the students thought they learned*), there was no difference between the triarchic and critical thinking groups, but both groups showed ratings significantly higher than those of the conventional-teaching group (t=3.92, p<.0001, and t=2.50, p<.01, for the triarchic and critical thinking groups, respectively). Finally, for the third question (*How well the students thought they did*), the triarchic group students gave higher ratings

than did the students in either the critical thinking group (t=5.95, p<.0001) or the conventional group (t=7.54, p<.0001), but the two non-triarchic groups did not differ from each other.

Middle School Project Study

Method

Participants

The middle school project was conducted in collaboration with the Center for Academic Advancement (CAA), a program in gifted education at the Johns Hopkins University. In summer of 1996, researchers at Yale designed and implemented a summer-school course in introductory psychology for CAA students. The participants included 141 rising eighth grade students (68 boys and 73 girls). Drawn from around the nation, the predominantly Caucasian student population hailed largely from middle-class and upper-middle-class backgrounds. The course was taught by six experienced teachers of secondary-level psychology, all of whom were active in Teaching of Psychology in Secondary Schools (TOPSS), a special-interest group of the American Psychological Association.

Ability Testing

A central goal of CAA is to identify gifted students and to provide them with academically challenging courses. CAA employs scores on the verbal battery of the SAT examination as the basis for identification of the gifted. Students were admitted to the psychology course based on an SAT-verbal score of 420 or higher. Admitted students had a mean SAT-verbal score of 471.13 with a standard deviation of 40.85.

Instructional Treatment

As in the primary school project, participating secondary-school teachers received an extensive training program prior to the intervention. The training program focused on techniques for infusing the appropriate instructional strategy into all aspects of the course—lecture, discussion, collaborative-learning groups, and individual assignments. In the triarchic-instruction group, teachers participated in workshops emphasizing the application of analytic, creative, and practical skills to the teaching of psychology. For example, having students frame their own research questions and design their own experiments were considered as tactics for bringing creative abilities to bear in the classroom. The critical thinking training-program was devoted to explication of the use of analytical reasoning in psychology; for example, tactics suggested for encouraging critical thinking in the classroom included having students analyze the flaws in a research project. The traditional instruction group received a training program on an irrelevant topic—portfolio assessment in the middle school classroom. None of the teachers collected portfolios during the intervention.

The 10-section course took place in two intensive 3-week sessions. Classes met 5 days per week with 7 hours of class time per day. An introductory-psychology text by Myers (1996) was used in all sections. Topics included neuroscience, development, perception, consciousness, learning, memory, language, intelligence, motivation, affect, personality, psychological disorders, therapy, and social psychology.

Research activities were conducted at two sites. At Goucher College in Baltimore, MD, eight sections of the course were taught to 120 students. Of these eight sections, four received triarchic instruction (n=60), two received critical thinking instruction (n=30), and two received traditional instruction (n=30). At the State University of California at Fresno (in Fresno, CA), two sections of the course were taught to 21 students. Students at Fresno received critical thinking instruction, bringing to 51 the total number of students in the critical thinking group. Six teachers were involved in the project, five located at Goucher and one at Fresno. Two teachers were assigned to each of the three instructional treatments.

To illustrate the three different teaching strategies as they apply to introductory psychology, it is useful to compare three ways to teach about a common psychological disorder—depression. In traditional instruction, a typical approach is to have students memorize theoretical constructs and research findings (e.g., summarize a biological perspective on depression). In critical thinking instruction, students are typically asked to compare, contrast, and evaluate different theories of depression (e.g., compare and contrast the biological and socio-cognitive perspectives). In triarchic instruction, students are encouraged to bring a combination of analytical, creative, and practical abilities to the fore; for example, students might be asked to generate their own theories of depression (creative), design therapeutic regimes that draw on the new theories (practical), and contrast these ideas with the work of biological and socio-cognitive theorists (analytical).

During the intervention, students received instruction that reflected the differences between the three strategies. In the traditional instruction group, the students participated in activities (e.g., discussions, writing tasks) that emphasized memory abilities:

> Obedience to authority is a topic of interest to social psychologists. Who are some of the psychologists that conducted important research on obedience? What motivated this research? What sorts of research methods did they use? What did the researchers find?

In the critical thinking group, the activities typically required students to employ analytical-reasoning abilities:

> Sigmund Freud and Gordon Allport put forth different theories of human personality. What did each theorist seek to explain? On what assumptions does each theory rely? How are the theories similar? How are they different? Which of the two do you more agree with, and why?

In the triarchic-instruction group, creative and practical abilities were emphasized as well as analytical and memory-based abilities:

> Why do you think that people sometimes fail to transfer skills or information when they need to? Think of a time when you did transfer when you should not have. Then think of a time when you did not transfer but should have. Why did these things happen? From your own life, come up with an explanation for why transfer does and does not occur when it is appropriate. (Creative)
>
> Measurement error is a problem for many kinds of tests. This error is due to extraneous influences that can make people's scores unreliable. Imagine that you have a new job at the Educational Testing Service (ETS) to reduce measurement error on the Scholastic Assessment Test (SAT). What kinds of measurement errors do you want to reduce, and how will you do it? Feel free to suggest strategies that ETS might not like but which you think will reduce measurement error. (Practical)

Knowledge-based Assessment

To evaluate student achievement during the course, two types of assessment instruments were employed. First, multiple-choice questions from the Myers (1996) test bank were used to capture students' understanding of course content. The midterm examination and the final examination each included 21 multiple-choice questions, yielding a total of 42 multiple-choice items. Second, performance assessments were employed to capture students' abilities on analytical, creative, and practical tasks. The midterm and final exams included analytical, creative, and practical performance assessments in the form of short-answer essay items. There also were three assignments in the form of extended essays (one each was analytical, creative, and practical). The three short-answer items on the final exam give the flavor of the performance assessments used in the study:

> June is so preoccupied with keeping her house absolutely spotless that she has no time to do anything but clean. After each meal she not only washes the dishes, but also the table, chairs, floor, and cupboards. Although these cleaning rituals irritate her family, June is unable to discontinue them without experiencing intense feelings of discomfort. Use the *psychoanalytic* and *learning* perspectives to explain June's behavior. How do these perspectives compare and contrast? What are the strengths and weaknesses of each approach? (Analytical)
>
> Psychologists have shown that people sometimes cling to their beliefs in the face of contrary evidence. This is called belief perseverance. Give an example of belief perseverance. Then come up with your own theory that explains why people act this way. Be specific about how the theory explains your example of belief perseverance. (Creative)

You are in charge of the fund-raising committee for a club at school. You want to make sure that candy bar sales are strong. How would you go about training your club members to be effective salespersons? Design and describe your sales program, basing it on principles of social psychology. (Practical)

Data Analysis

As in the primary school project, the performance assessments were scored by three raters who had no knowledge of the research design or hypothesis. The raters used a five-point Likert-type scale to rate the overall quality of each of the responses and met frequently for several weeks to tune the rating process. Correlations among the ratings given by pairs of raters for the nine performance items ranged from .76 to .80. The overall correlation of .83 is sufficiently high for us to conclude that the ratings provide a reliable assessment of learners' responses to the performance assessments.

Results and Discussion

Outcome Measures

To reduce the number of dependent variables, we investigated whether summary measures of the students' performance on the two exams and the homework assignment would be adequate representations of the initial 9 outcome measures. The principal-component analyses resulted in a one-component solution for the analytical performance measure, and in two-component solutions for both practical and creative performance measures. In both cases, the first component accounted for about 40% of shared variance in exams and assignment measures, whereas the second component (about 35% for both) was introduced by the variance in the assessment method (the examination scores and the assignment score loaded with opposite signs). Based on these results, in the subsequent analyses six different outcome measures were utilized: analytical, creative, and practical measures for the homework assignment and the two exams (summary measure). Thus, there were 7 main outcome variables in the analyses: measures of assignment and examination performance on analytical, creative, and practical tasks, and the multiple-choice measures.

Preliminary Analyses

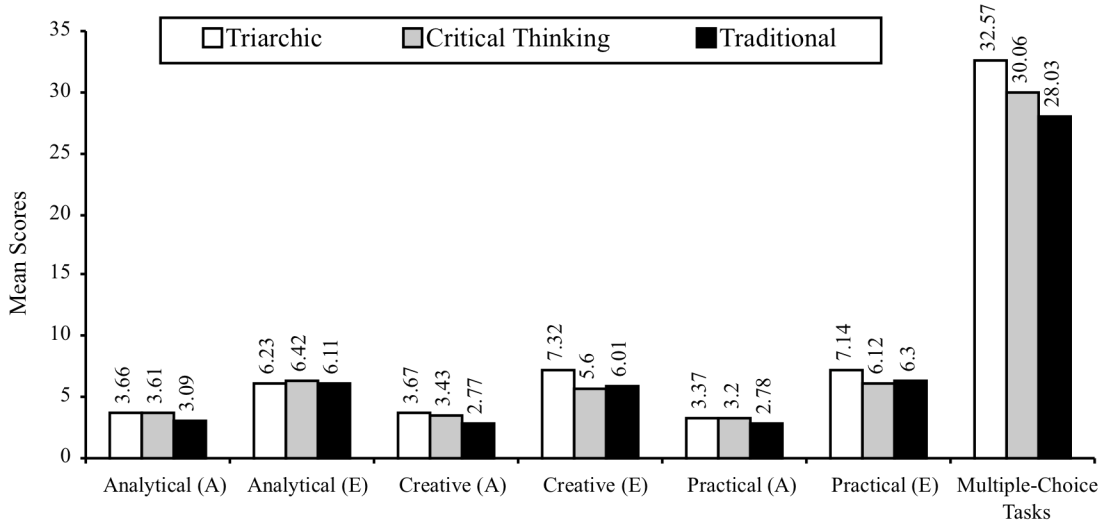
Two variables—gender and the SAT ability score—were considered to be of potential importance in the treatment-effect analyses. Multivariate analysis of variance did not reveal the presence of gender effects on any of the outcome variables. Similarly, the SAT scores did not appear to be significantly related to the performance measures. When the correlations between the SAT scores and the initial performance measures (two examinations and the assignment) were examined, only one correlation, the correlation with the analytical subtest of the final exam, was significant (r=.189, p<.05). Moreover, there were no SAT-related group differences or differentiative correlation patterns across the treatment groups. Therefore the subsequent analyses of variance did not include any covariates.

Treatment Effects

Multivariate analysis of variance, profile analysis, and pairwise least-squares mean comparisons were implemented to evaluate the effect of teaching on students' performance.

Three different tests were performed comparing the profiles of scores in the three treatment groups. The least-squares means groups profiles are shown in Figure 1.3. The flatness test of the group profiles suggested that the investigated group profiles were non-horizontal: For this test, Wilks' Lambda was .01 ($F_{(6,133)}$=1718.27, p<.0001). The parallelism test demonstrated that the compared profiles were different for the three groups (Wilks' Lambda=.54, $F_{(12,266)}$=7.93, p<.0001). Finally, the levels test examined differences between the means of the three treatment groups combined over the seven assessments. This analysis demonstrated that, overall, there was a significant difference between treatment groups in average performance on different types of assessments ($F_{(2,138)}$=50.04, p<.0001). Specifically, the contrast analyses across averaged transformed variables resulted in the following estimates: 2.08 ± .30 (the triarchic group versus the critical thinking group) and 3.35 ± .36 (the triarchic group versus the conventional group). There were no differences between the critical thinking and the conventional group. These results suggest that the triarchic group, on average, performed significantly better than either the critical thinking group or the traditional-teaching group.

A series of subsequent univariate analyses revealed significant F-values for six out of the seven investigated equations (Table 1.2).



Note: (A)—homework assignments (E)—examinations

Figure 1.3. Means in the Middle School Project Study: Assessments of achievement.

Table 1.2

Effects in the Middle School Project Study

Assessment	*F*-value	*p*-value	R^2
Analytical (assignment)	6.16	<.005	8%
Creative (assignment)	14.37	<.0001	17%
Practical (assignment)	4.75	<.01	6%
Analytical (examinations)	.66	ns	
Creative (examinations)	47.39	<.0001	41%
Practical (examinations)	16.56	<.0001	19%
Multiple-choice tasks	19.55	<.0001	22%

These results were followed up by a series of pairwise comparisons of least-square means (see Figure 1.3). For performance on analytical tasks assessed through homework, both the triarchic group and the critical thinking group performed better than did the traditional group (t=3.34, p<.001 and t=2.98, p<.005, respectively) but did not differ from each other. Similarly, for homework-assignment performance on creative tasks, there was no significant difference between the triarchic and critical thinking groups, but both groups performed better than did the traditional group (t=5.34, p<.0001 and t=3.81, p<.001 for critical thinking and conventional groups, respectively). The pattern was also replicated for the practical homework assignment. Students from both the triarchic and the critical thinking group performed significantly better than did students from the conventional teaching group (t=3.08, p<.005 and t=2.12, p<.05, respectively). The two groups, however, did not differ from each other.

For the examinations, the pattern of the least-square means was very different. The three groups did not differ in their average performance on the analytical tasks of the examination. The groups differed significantly, however, on both creative and practical tasks. For the creative tasks, the triarchic group did better than did either the critical thinking group (t=9.38, p<.0001) or the traditional group (t=6.07, p<.0001). The difference between the critical thinking and the traditional group was borderline significant (p<.07), with the traditional group performing slightly better than did the critical thinking group. Similarly, on the practical tasks, the triarchic group performance was the highest and significantly different from the performance of both the critical thinking group (t=5.46, p<.0001) and the traditional group (t=3.81, p<.001). Students in the critical thinking group and the conventional teaching group did not differ.

Finally, the triarchic group students performed better on the multiple-choice test. This difference was statistically significant both when compared with the performance of the students whose teaching was based on the critical thinking approach (t=3.91, p<.0001) and when compared with the performance of those who received traditional teaching (t=6.02, p<.0001). Moreover, the critical thinking group did better than did the conventional teaching group (t=2.61, p<.01).

General Discussion

Students in two studies who received triarchic instruction generally learned more than did students who received either conventional memory-based or analytically-based instruction. Greater learning was shown for a variety of kinds of assessments, including both memory-based ones that were already in use, and performance-based ones that were designed especially for this project. The two experiments reported here thus suggest that students benefit from triarchic instruction, not only if it is matched to their pattern of strengths (Sternberg et al., 1996), but also if it is given in equal fashion to all students.

Of course, we make no claim that only triarchic instruction will improve achievement. Instruction based on other theories of intelligence (e.g., Gardner, 1993) might also result in enhanced achievement. Moreover, the two studies here represent tests of the theory at just two age levels, for two subject-matter areas, and in a limited number of settings. Clearly, it is premature to make any generalizations. At the very least, though, the results suggest that further testing of the triarchic theory in the classroom might be worthwhile.

Quasi-experimental studies done in actual classroom settings often have certain design limitations, and it behooves us to mention some of these possible limitations here as they apply to our own work.

First, we used intact classes in which neither assignment of pupils nor of teachers to classes was random. Ideally, of course, these assignments would be random. To compensate for nonrandom assignment of pupils to classes (and hence to conditions), we used mental-ability-test scores as covariates. These covariates (the Otis-Lennon Intelligence Scale in the Primary School Project Study and the SAT in the Middle School Project Study) proved to be only weakly correlated with outcomes, however. It is not immediately obvious what might have served as more appropriate covariates. A measure of socioeconomic class is a possibility, but within study, there was not much variation in socioeconomic class among the participants (generally lower in the Primary School Project Study and middle to upper-middle in the Middle School Project Study). Scores on a triarchic ability test might be appropriate, but we have no such test for the age levels we studied, and moreover, the test we have is not normed and standardized. A measure of achievement would be inappropriate because then we would be using achievement both as a dependent measure and as a covariate, which does not make sense. In sum, we chose plausible measures as covariates, but they proved to be only weakly related to treatment effects. In any case, the similarity of patterns of results for the two studies tends to counterindicate prior group differences as being responsible for the results.

Second, one might argue, that "the traditional instruction sounds deadly," and thus might have produced weaker gains because it encouraged students "to tune out." But this argument is not an indictment of our study, but of the existing educational system in which children are educated. Students in the traditional instruction group received the regular instruction they would have received if we had not intervened. Their instruction was of the kind that millions of students in the U.S. and elsewhere receive every day.

Third, one could argue that the results were due to some kind of Hawthorne effect, whereby teachers or students in better-performing groups were more motivated to do well or to please the researchers than were students and teachers in the weaker-performing groups. This explanation is implausible, however. All teachers received an intervention that was designed to improve their teaching competencies. There is no a priori or a posteriori reason to believe that our interventions with different groups of teachers were differentially motivating.

Finally, it may be, that the advantage of triarchic instruction is that it is more "exciting." If that is the reason for the greater gain in the triarchic condition, we accept the reason with pleasure. We are all in favor of producing teaching that stimulates and excites students and thereby leads to improved performance. We cannot and would not rule out greater excitement as one possible source of our effects, although the generality of the gains across ages, subject matter, and dependent measures suggests that perhaps other factors were operating as well.

We believe that there is a strong need for a teaching to all abilities, and then assessment of achievement based on such broad teaching. Too often, teaching and assessment do not match. For example, one might teach to broad aspects of intelligence, but then assess students' achievement only for memory-based outcomes. We believe that modern-day theories of intelligence and related cognitive functions have a great deal to offer to the education of our children, and that the sooner we incorporate in our "school-reform" efforts not just restructuring based on theories of management, but restructuring taking into account modern theories of intelligence and learning, the sooner we will see enhanced learning outcomes on the part of our students.

Intervention Study II—School-based Tests of the Triarchic Theory of Intelligence: Three Settings, Three Samples, Three Syllabi

Elena L. Grigorenko, Linda Jarvin, & Robert J. Sternberg

Introduction

Many efforts have been made to improve students' achievement in school, but relatively few of these efforts have derived from psychological theories of intelligence and related constructs. Ironically, perhaps, one of the earliest efforts—the "mental orthopedics" of Binet and Simon (1916)—was based on a theory, Binet and Simon's own. This theory emphasized the importance of good judgment, reflection, and self-criticism in the learning process. Most subsequent efforts, however, have not been closely tied to any theory. There are numerous exceptions, however (see, e.g., Baron & Sternberg, 1987; Bransford & Stein, 1993; Costa, 1985; Feuerstein, 1980; Grotzer & Perkins, 2000; Halpern, 1996; Meeker, 1969; Nickerson, 1994, Nickerson, Perkins, & Smith, 1985; Perkins & Grotzer, 1997; Sternberg & Bhana, 1986; Sternberg & Grigorenko, 2000; Sternberg & Spear-Swerling, 1996).

Can theories of cognition or of intelligence be infused into existing curricula so as to improve both school achievement and the cognitive skills that contribute to it? Some theorists believe they can be (e.g., Swartz, 1987). Perhaps the most well-known attempts are based on the theory of multiple intelligences proposed by Gardner (1983, 1993, 1999). These attempts have met with mixed success (Callahan, Tomlinson, Moon, Tomchin, & Plucker, 1995), although many of the evaluations are informal or uncontrolled so that it is hard to know exactly what the outcomes have been, and sometimes, the programs have not been true to the theory (see Gardner, 1993, 1995b).

The goal of the three studies is to test the efficacy at the primary and secondary levels of instruction based on the triarchic theory of intelligence (Sternberg, 1985, 1997a, 1999a) that is infused into already existing curricula. According to the triarchic theory, human intelligence comprises three main aspects: analytical, creative, and practical. Infused into instruction and assessment, analytical tasks involve analyzing, judging, evaluating, comparing and contrasting, and critiquing; creative tasks involve creating, inventing, discovering, imagining, and supposing; and practical tasks involve implementing, using, applying, and seeking relevance (Sternberg, 1994a, 1994b). More conventional memory-based instruction involves memorizing, remembering, recalling, recognizing, and repeating.

In some of our earlier work, we attempted to infuse a portion of this theory (the practical part) into the curriculum, combining it with Gardner's theory of multiple intelligences (Gardner, Krechevsky, Sternberg, & Okagaki, 1994; Sternberg, Okagaki, & Jackson, 1990; Williams, Blythe, White, Sternberg, & Gardner, 1996). We then moved to infuse the entire theory into the curriculum.

In one project (Sternberg & Clinkenbeard, 1995; Sternberg, Ferrari, Clinkenbeard, & Grigorenko, 1996; Sternberg, Grigorenko, Ferrari, & Clinkenbeard, 1999), we infused the triarchic theory into instruction and assessment in a psychology curriculum taught to high school students selected for a special summer program at Yale University. Students were chosen to represent particular ability patterns, and then were given instruction that either more closely or more distantly matched their patterns of abilities. All students were assessed for achievement in terms of multiple-choice memory tests, as well as for analytical, creative, and practical performances. We found that students who were better matched to instruction in terms of their patterns of abilities outperformed those students who were more poorly matched.

In a subsequent set of studies (Sternberg, Torff, & Grigorenko, 1998a), primary and middle school groups received instruction in existing curriculum units in social studies and science, respectively; the instruction was either enhanced via the triarchic theory or it was not. Two control conditions were used for evaluation of the efficacy of the instruction. The first was a traditional instruction group, in which students received exactly the instruction that they would have received without the experimental intervention. The second and stronger control group was one that received instruction enhanced by the infusion of critical- (analytical-) thinking skills, which represent the most frequently used kind of infusion, but which represent only part of what the triarchic theory would suggest needs ideally to be infused into the curriculum. We found that all students benefited, on average, from triarchically based instruction relative to the other instructional conditions. These benefits occurred both for performance assessments that were analytically, creatively, and practically based, and for conventional assessments, which were memory based. In other words, triarchically based instruction resulted in better performance on memory-based tests than did memory-based instruction. Why should triarchically taught students show such increases?

We predicted then, and predict for the present set of studies, that triarchic instruction should improve school performance relative to many other forms of instruction. There are four basic reasons why triarchic instruction should work, in general, and a further reason why it should work especially in the context of reading.

First, triarchic instruction should enable students to encode the information to be learned in three different ways (analytically, creatively, and practically), as well as for memory. The multiple encodings of information should improve learning. Using this approach, students think to learn, and simultaneously learn to think.

Second, triarchic instruction should result in a higher proportion of elaborative rehearsal relative to maintenance rehearsal than should conventional instruction. Elaborative rehearsal, which involves elaborating encodings in meaningful ways, typically results in better recall than does the relatively mindless repetition of sets of words associated with maintenance rehearsal (Tulving, 1966).

Third, triarchic instruction should enable students to capitalize on their strengths and to compensate for or correct their weaknesses, a key aspect of triarchic instruction, as

well as of all instruction based on notions of aptitude-treatment interaction (Cronbach & Snow, 1977). In other words, there should be at least some instruction that would be compatible with almost all students' strengths, enabling the students to bring these strengths to bear on the work at hand. At the same time, at least some of the instruction would probably not correspond to students' strengths, encouraging the students to develop modes of compensation for and correction of weaknesses. Instruction that enables students to capitalize on strengths is also likely to motivate students more than instruction that does not allow such capitalization.

Fourth, triarchic instruction should be more motivating to students simply because it makes the material to be learned more interesting. Indeed, when we queried students regarding their engagement in the material, we found triarchic instruction to be very successful in capturing the interest of the students (Sternberg et al., 1998a).

Fifth, triarchic instruction strikes a balance, in reading instruction, between phonic and whole-language methods. Rather than being bound to a preexisting ideology of reading instruction, it seeks the kind of balance that has been demonstrated to be most effective in teaching children to read (Pressley, 1998).

The basic strategy for our studies was to (a) divide students into two groups, experimental and control, using standardized assessments of achievement to analyze the prior comparability of the groups; (b) provide different instructional treatments, corresponding to two types of instruction (triarchic and traditional); and (c) administer knowledge-based assessment measures, to examine differences that might obtain in outcomes generated by the two instructional treatments. This protocol was conducted with three groups of students, two at the middle school level and one at the high school level.

The present studies went beyond our previous studies in seven major respects.

First, our primary focus was on improving instruction through improving reading skills. Our core assumption was that, in all subject-matter areas, lower achievement sometimes derives from students' simply not being able well to understand what they are reading.

Second, we extended the subject-matter areas in which we did our interventions. We intervened not only in reading and language-arts curricula, but also (at the high school level), in reading as it pertains to mathematics, physical sciences, history, foreign languages, and the arts. Our goal was to show that triarchic teaching works in improving vocabulary and comprehension skills in virtually any subject-matter area.

Third, we limited our interventions exclusively to triarchic enrichment of existing curriculum materials and curriculum-related supplementary materials. Our previous work had suggested to us that most teachers do not want yet another thing to teach, nor do they want an entirely new set of materials that completely replaces the materials they already have familiarity with and some experience in teaching. Rather, they want better

to teach the materials they already are teaching. We therefore worked with existing basal programs or particular textbooks, and showed teachers how to use them more effectively.

Fourth, one of our studies involved two separate waves of instruction at a single site. By doing two waves, it was possible to determine whether improvements in a site noted in a first wave could be replicated at the same site in a second wave of instruction.

Fifth, almost all of the students who received triarchic instruction in all studies were inner-city students from low to very low SES neighborhoods with extremely diverse ethnic characteristics. Many of them would be characterized as "at risk" because of the impoverished environments in which they grew up.

Sixth, all studies presented here had elements of action research—teacher-performed educational activities, directed toward bridging research and educational practice (McNiff, 1992). Specifically, we expanded the teachers' repertoire, enhanced their knowledge base, demonstrated research-based models of linking teaching and assessments, provided structured teaching and assessment materials, provided means for analysis of students' work, and created situations of collaborative reflection at annual round-table discussions of the educational activities.

Seventh, one of the major goals of this set of studies was to test the generalizability of a triarchic intervention to the real world of the school. Specifically, we explored (a) the teacher-based models of delivery of triarchic intervention programs; (b) the sustainability of changes in teaching initiated by participation in teachers' workshops and supported primarily by a modified curriculum; (c) the applicability of triarchic interventions to large samples of children including students of all levels of ability who were receiving different types of general teaching instruction (regular or special-educational instruction); and (d) the robustness of triarchic instruction in the midst of a variety of school-based interruptions of instruction and of the extent to which triarchic instruction can be integrated into the normal public-school curriculum.

The Curriculum-based Middle School Study

The main objective of the Curriculum-based Middle School Study was to develop, implement, and evaluate a triarchic enrichment of an existing reading curriculum. We sought to modify the current reading program of the New Haven Public School District so that its content would be preserved but the methods of teaching could be enriched. The main question was whether we could improve students' reading skills by enrichment of teaching methods within the context of an extant basal-based reading program. In this program, experimental group teachers taught the subject matter they would have taught anyway, but they taught it triarchically. Control group teachers taught in their normal manner with enhanced emphasis on the use of mnemonics and other strategies for enhancement of memory for material that has been learned. Thus, enhancement in the experimental groups was in terms of triarchic thinking and in control groups was in terms of memory.

The program was implemented for two consecutive years, serving, altogether, 809 students. In each year, the program was administered in three phases. In Phase 1, *Conventional Instruction and Evaluation,* all students received identical, conventional reading instruction with the materials they normally used and were evaluated for their reading performance. In Phase 2, *Transition,* the control group continued with conventional reading instruction with their normal materials taught with enhanced emphasis on mnemonics and other memory aids, whereas the experimental group transitioned to triarchic instruction. The purpose of this (unevaluated) phase was to give experimental group students an opportunity to adjust to triarchic instruction and to continue conventional but memory-enhanced reading instruction with control group students. In Phase 3, *Differentiated Instruction and Evaluation,* the control group continued with conventional but memory-enhanced instruction and the triarchic group continued with triarchic instruction. Both groups were again evaluated for their reading performance. Thus, the overall goal of the program was to verify whether triarchically-enhanced instruction based on commercial textbooks will improve students' performance as compared with traditional instruction based on same commercial textbooks.

Thus, in terms of specific differences between the Curriculum-based Middle School Study and our other studies, this research (a) attempted to improve children's reading skills by building vocabulary and enhancing comprehension skills, (b) relied exclusively on the standard program material, (c) implied a test of the robustness of the program by administering the program in two consecutive years, (d) included a population of low SES, inner-city, ethnically diverse fifth graders, (e) implemented elements of action research to change teachers' behavior in the classroom and to supplement these changes with instructional material, and (f) implied a test of the generalizability of the triarchic instruction by upscaling the research to larger groups of participants and making the program a component of a school's routine.

Method

Participants

The participants in the Curriculum-based Middle School Study were middle school students. For the first-year study, the participating schools were nominated by the New Haven Public School District.

Year 1. A total of 323 fifth grade students—149 girls (46.1%), 151 boys (46.7%), and 23 children whose gender was not specified (7.1%)—participated in the Curriculum-based Middle School Study.[1] Of these students, 40.9% were African American, 20.1% Hispanic American, 9.3% European American, 5.9% from other ethnic minorities, and 23.8% for whom ethnicity was not registered. These 323 students attended four middle schools, two of which were randomly assigned to the triarchic teaching condition and two to the control condition.

Assignment to conditions was by school in order to minimize the cross-contamination that can occur when teachers talk to one another about what they are

teaching and how they are teaching it. All but one of the fifth grade teachers in the four schools participated in the study. The teacher who did not participate was a new teacher just starting her career, and her decision not to participate was supported by her school's principal. This teacher, however, did take part in the study in Year 2. Altogether, there were 13 teachers. The triarchic sample included 147 students (45.5%), and the control sample, 176 students (54.5%). There were no significant differences in gender or ethnic composition between the two samples.

Year 2. As in Year 1, school recruitment was done by officials of the New Haven Public School District. A sample of 486 fifth grade students—238 girls (49%), 230 boys (47.3%), and 18 children whose gender was not specified (3.7%)—participated in the study.[2] The ethnic breakdown of the sample was 39.5% African American, 19.3% Hispanic American, 13.0% European American, 9.1% of other ethnic backgrounds, and 19.1% for whom ethnicity was not registered. These 486 students attended seven middle schools, four of which (2 triarchic and 2 control schools from Year 1) were in the Year 2 triarchic teaching group, and three of which were newly enrolled schools from the New Haven School District. In Year 2, 20 teachers participated in the study. Seven of the experimental group teachers had previously served in the control group, but none of the control group teachers previously had served in the experimental group. The triarchic sample included 350 students (72%) and the control sample included 136 students (28%).[3] There were no significant differences in gender composition between the two samples. There were, however, ethnic differences: Hispanic American and children of other ethnic backgrounds were under-represented, whereas European American children were over-represented in the control sample (χ_4^2=46.2, p<.00).

To explore the possibility of combining the samples from Year 1 and Year 2 for the analyses, we investigated the group differences in the samples' performance by year.[4] Half of the year-based comparisons were significant; however, the directions of higher performance were variable. Specifically, in some cases, Year 1 students out-performed Year 2 students, whereas in others, Year 2 students out-performed Year 1 students. Therefore, the decision was made to combine the two samples, controlling for the year of program administration (e.g., specifying the variable *Year* as a covariate).

Combined sample. Thus, altogether, 809 fifth grade students participated in the study. However, only 708 students were present in school at the time when all of the eight assessments (4 for pretest and 4 for posttest) were administered. (There were no demographic differences between those students who completed all assessments and those students who missed some assessments.) Here we present the data only from those 708 students. Of them, 298 were boys (42.1%) and 313 were girls (44.2%) girls; the district files did not provide information on the gender of 97 children (13.7%). The ethnic composition of the sample was as follows: 309 (43.6%) of the children were African American, 155 (21.9%) Hispanic American, 53% (7.5%) European American, 83 (11.7%) were from other ethnic minorities, and 108 (15.3%) either did not register any ethnicity or had multiple entries in the district files. There were 450 students in the triarchic group and 258 students in the memory control group.

Materials[5]

Instructional and Assessment Materials

Six stories from the fifth grade basal reader, Light Up the Sky (Farr & Strickland, 1993), were used in the program. Two stories ("The Speech" and "Teacher for the Day") served as Phase 1 units, two other stories ("New Home in Ohio" and "The Great Caravan on the National Road") served as Phase 2 units, and two further stories ("Like Jake and Me" and "Many Moons") served as Phase 3 units. For all units for all students, the following assessment materials were developed: (a) homework assignments (from which students were given a choice of one assignment from a list, including memory-analytical, creative, and practical assignments); (b) vocabulary assessment (18 items: 6 memory-analytical, 6 creative, and 6 practical); and (c) comprehension assessment (18 items: 6 memory-analytical, 6 creative, and 6 practical). The assessments for different stories were designed to approximate each other in degree of difficulty. Homework assignments were graded by teachers but because the homework was viewed as an instructional activity the grades were not analyzed as part of the study. Teacher's guides were developed for the Phase 2 and Phase 3 stories based on the triarchic paradigm. These guides showed teachers how to teach traditional language-arts skills (vocabulary, spelling, reading comprehension, and writing) so as to call into play and develop students' analytical, creative, and practical abilities and achievement. In addition, the instructional materials were designed to help students develop the triarchic-theory-based skills so that they could apply these skills directly to the improvement of their proficiency in reading subject matter. Teachers in the control group were shown how to apply mnemonic strategies to material to be taught.

Consider some examples of each kind of material, as manifested in in-class and homework assignments. The materials were designed for the actual textbook the children were using, *Light Up the Sky* (Farr & Strickland, 1993). Although activities are classified loosely as *analytical*, *creative*, and *practical*, these classifications represent emphases rather than fully discrete categories. Ultimately, we wanted children to learn to combine these skills rather than merely to use them separately.

In-class Instructional Material

These materials are used in class to develop analytical, creative, and practical thinking skills applicable to reading:

Analytical

Analytically oriented exercises encourage students to analyze, evaluate, judge, and compare. The following exercise also helps students learn to develop these skills in collaboration with other students. Following is a set of instructions to teachers:

> . . . Divide the students up into small groups and give each group a big piece of poster board and assorted colored pens, pencils, etc. . . . Tell the students that they

> are to spend time with their groups making a "portrait" of their assigned character. Emphasize that they should use their own understanding of a character based on the details in the story itself. Try to stress they should focus on what the words in the story tell them about the characters. . . .

Creative

The goal in creatively oriented items is for students to imagine, invent, discover, and explore. In the exercise below, students are asked to provide their own "words of wisdom" on challenging questions to which they are unlikely to know any "correct" answers. Indeed, there are no "correct" answers.

> Words of Wisdom
> By (Write your royal title here) _____
>
> - Why are there rainbows after a storm? How do rainbows get to be so many different colors? How can you get the pot of gold at the end of a rainbow?
> - Why do cows say "Moo" all the time? Why does this one word play such a big part in cow language? What are the cows saying?

Practical

The goal in practically oriented exercises is to encourage students to think of practical angles on what they read—to apply, use, implement, and put into practice what they learn. The sample exercise below helps develop practical route-planning skills.

> . . . Remind the students that, as they learned in the story, many slaves ran away from their masters and fled to the North, often with the assistance of the Underground Railroad. Tell the students that today they are going to do another small-group exercise to think more about what it must have actually been like to run away from slavery. . . . Each group is to imagine that . . . [its] coming up with a plan for a slave to travel from slavery in North Carolina to Canada [using a map, a set of tools, and a set of survival rules].

Homework Instructional Materials

These materials are used as homework instructional materials to help children develop analytical, creative, and practical thinking skills on their own.
Analytical

In the following exercise, students need to reflect on an experience and then describe, analyze, and communicate it so that another individual can understand it.

> Suppose you have just spent a special holiday with your relatives and friends. Your favorite cousin could not be there because he is in the army and is stationed

far away. Write your cousin a letter fully describing and analyzing the big day so that he will feel almost as if he had been there.

Creative

The children have read a story about the Bell family that refers to some good times and some bad times for the family. But these events are not fully described. The students are asked to take off from the text and to invent descriptions of these events.

The story is, in part, about the Bells' family history—the "good times" and "bad times" they have experienced living for generations along the National Road. Think of at least one good time and one bad time the Bell family could have experienced. Imagine what could have happened. As fully as you can, describe what these events may have been like and explain their importance to the Bell family.

Practical

An important part of everyday life is preparing for major events. In the story the children have read, the characters are preparing for such major events. Children are asked to place themselves in the role of the main characters and to describe what they would do to prepare for a big family relocation that is about to take place.

Moving can be difficult. But Thomas is excited about moving to his new house partly because he knows so much about its interesting past. Pretend you are moving to a new place. What are some things you could do before you moved to make the change easier?

Examples of Assessment Materials

Below are some examples of actual material used to assess readers' analytical, creative, and practical vocabulary and comprehension skills. The first set of items measures vocabulary skills. Targeted vocabulary words are shown in italics. The second set of items measures reading-comprehension skills.

<u>Vocabulary Skill Test Items</u>

Analytical

In everyday reading, children almost never need to recognize vocabulary words out of context, as they sometimes do on vocabulary achievement tests. Words almost always occur in a context. We thus assess children's vocabulary skills in natural reading contexts, as shown below:

Scott played in the school marching band. On St. Patrick's Day the band was going to march in the town_____. Scott was excited. He liked music, floats, and crowds of people.

Which is the best choice to fill in the blank above?

a) *parade*
b) meeting
c) hall
d) movie

Creative

It is important for children not only to be able to recognize the meaning of a word but to use the word in a sentence. Sometimes children are able to recognize the meaning of a word on a multiple-choice test but not actually to use the word. We thus measure their ability to create a sentence that uses the word appropriately.

Think of and write down a sentence with the word *imagination* in it.

_____

Practical

If a student truly understands the meaning of a word, he or she should be able to use it in context to understand what it signifies practically. We measure this skill below.

After singing with the church choir three times on Christmas, Jodi found that her voice had become *hoarse*. To solve her problem, she should

a) quit the choir.
b) do some sit-ups before going to bed.
c) learn more about horses.
d) drink some tea and try not to talk.

<u>Reading Comprehension Skill Test Items</u>

Analytical

An important analytical skill is that of comparing and contrasting. We measure this skill by asking students to think about similarities and differences in the stories' characters or their opinions.

How would you say the descriptions of the moon provided by The Lord High Chamberlain, The Royal Wizard, The Royal Mathematician, and The Jester are different?

_____

Creative

In the task below, children are asked to create a description of a stage, given the context in which the stage occurs in the passage that they have been reading.

> A theater company is putting on a play about Belva's life. The theater company has hired you to make the stage look like the inside of the schoolhouse where Belva went to school. Come up with the design for the stage.
>
> _____

Practical

An important practical skill is in knowing how to behave in social situations. The task item below taps into this skill.

> Geraldine had just gone hiking in the woods. When she told her father where she had been, he said, "I hope you didn't get any ticks on you!"
>
> What should Geraldine do?
>
> a) Geraldine should sit down and watch TV.
> b) Geraldine should glance quickly at each of her hands.
> c) Geraldine should put her clothes aside to be washed and carefully check her whole body for ticks.
> d) Geraldine should stomp her feet really hard in the living room.

Affective Evaluations

To evaluate affective outcomes of the reading program, affective evaluation forms were offered to students and to teachers. Teachers were asked whether they found the program to be professionally interesting and motivating. In addition, they were asked to evaluate the educational and motivational relevance of the program to their students and to estimate the power/suitability of the program for working with diverse groups of students attending urban schools. Students were asked whether/how much they liked the program and to indicate their favorite components of the program.

Design

The design was identical for Year 1 and Year 2. The critical independent variable in the Curriculum-based Middle School Study was teaching condition. There was one experimental condition and one control condition. The two conditions covered the same units from the basal reader used in the New Haven Public School District. The duration of the program was the same in each condition (4.5—5 months). Where the conditions differed was in the methods used in Phases 2 and 3 for teaching these skills: *triarchic instruction* (experimental) and *conventional (primarily memory-based) instruction* (control). The impact of the triarchic intervention was measured through (a) assessments

of students' performance and (b) affective evaluations by teachers and students. The performance assessments were administered both before (Phase 1) and after (Phase 3) the in-service program for the teachers. Thus, it was possible to compare pretest and posttest scores in the experimental versus the control groups. The four pretest assessments were the vocabulary and comprehension assessments for the two stories from Phase 1 ("The Speech" and "Teacher for the Day"). The four posttest assessments were the vocabulary and comprehension assessments for the stories from Phase 3 ("Like Jake and Me" and "Many Moons").

Procedure

Teacher Training

Teachers in the experimental group were invited to participate in a two-part workshop, of which the first part was dedicated to triarchic instruction and assessment and the second part to general issues of teaching reading in middle school. The training involved teaching teachers how to teach analytically, creatively, and practically. For example, teachers learned how to use prompts for analytical teaching (such as *analyze, evaluate, critique, judge*), creative teaching (such as *create, invent, discover, explore*), and practical teaching (such as *use, apply, implement, put into practice*). Instruction was based on material in Sternberg and Grigorenko (2000). Teachers in the control group were offered a workshop on memory mnemonics and related techniques relevant to the teaching of reading. These mnemonics included techniques such as use of interactive imagery, pegwords, keywords, acronyms, acrostics, the method of loci, categorical clustering, and hierarchical mental representations to recall material one has read (see Pressley, 1991; Pressley, Levin, & Delaney, 1982). Instruction was based on material in Sternberg and Grigorenko (in press). Each year of the study closed with a roundtable discussion in which teachers from both groups, triarchic and control, participated. The first year discussion resulted in adding new units to the instruction materials. Because second year control group teachers were all new (and hence did not participate in the roundtable discussion), their teaching could not have been affected by this discussion.

Thus, both the control and experimental groups received special interventions, but of different kinds. The control group received an intervention based on enhancement of memory for material that is read based largely on mnemonic techniques, an intervention not made available to the experimental group. The experimental group received an intervention based on enhancement of analytical, creative, and practical thinking, an intervention not made available to the control group.

Student Participation

Both instructional and assessment materials were administered by teachers. In both years, the program started in mid-February and ended in June. Activities were carried out individually, in small groups, and in the class group as a whole. Small groups were created informally in both the experimental (analytical, creative, practical) and control conditions on a temporary, ad hoc basis from day to day, with no attempt to

control for membership. To monitor the implementation of the curriculum, all teachers' classrooms were visited randomly at least twice during the intervention stage. The assessment materials were turned in by teachers immediately after they had been administered to students. If teachers chose to, they could assign their students a grade based on their performance on the assessment, however they were asked not to write that grade or any other corrections on the paper copy of the assessment that was turned in to Yale University. All scoring of the assessment for the evaluation purposes of the Curriculum-based Middle School Study was done at Yale University. Multiple-choice items were scored as right and wrong (1 and 0). Open-ended items were scored using rubrics (the final outcomes of this scoring also resulted in right and wrong answers; 1 and 0), by independent raters blind to the study conditions. Memory-analytical items were scored for the quality of analysis, creative items for novelty, task-appropriateness, and quality, and practical items for practicality. For each particular item, scoring rubrics were developed.[6] In addition, all open-ended items were rated for their general quality (e.g., spelling, sentence structure, and grammar).[7] Inter-rater reliabilities ranged from .60 to .99 for the Year 1 data (median: .92) and from .75 to .98 for the Year 2 data (median: .87). In Year 1, all materials were evaluated by two independent raters. As we discovered that the inter-rater reliabilities were generally high, in Year 2 only random cross-ratings by the second rater of 50 randomly selected sets of the materials were carried out. Because scores on vocabulary and comprehension assessments based on pre and posttest stories contained significant and substantial amounts of overlapping variance, for simplicity of presentation, the decision was made to combine scores on vocabulary and comprehension assessments across the two different stories within the pre and posttest.[8]

Results and Discussion

Students' skills were assessed separately by vocabulary and comprehension assessments at pre and posttest in two different samples, Year 1 sample and Year 2 sample.[9] The student-performance results and the affective-evaluation results are presented in a combined fashion for vocabulary and comprehension, together for Year 1 and Year 2.

Achievement Indicators

At the baseline, the groups were compared on (a) scores on a State of Connecticut standardized achievement test (the Connecticut Mastery Test, CMT) and (b) level of performance at the baseline (i.e., performance on pretest assessments).[10] The CMT was administered to children approximately a year and a half before they entered the study (in the fall of fourth grade); thus, although the CMT scores might have not been good indicators of the concurrent validity of our program, they served as the covariates of interest. For the baseline CMT scores, the performance of students in the triarchic and control groups were compared on *Degrees of Reading Power* (*DRP)*, a standardized reading test) and *Holistic Writing* (a standardized writing test) indicators. Both subtests assess skills that are called for in the performance assessments included in the study (open-ended items required writing). A multivariate test of the main effect of group

(triarchic versus control) was significant (Pillai's Trace=.022, $F_{2,698}$=7.9, p<.001); there was no effect of year of the study. Follow-up univariate analyses revealed two significant effects: (a) the *DRP* reading scores of the children in the triarchic group were significantly lower than those of the children in the control group, $F_{1,701}$=8.9, p<.01, estimated $\text{mean}_{\text{triarchic}}$=36.6 (with 95% confidence interval of 35.5-37.7) and estimated $\text{mean}_{\text{control}}$=39.4 (with 95% confidence interval of 38.0-40.9); and (b) the *Holistic Writing* scores of the children in the triarchic group were significantly lower than those of the children in the control group, $F_{1,701}$=8.1, p<.01, estimated $\text{mean}_{\text{triarchic}}$=6.0 (with 95% confidence interval of 5.5-6.6) and estimated $\text{mean}_{\text{control}}$=7.4 (with 95% confidence interval of 6.7-8.1). Therefore, the *DRP* and *Holistic Writing* indicators were included as covariates in subsequent analyses.

Baseline Differences in Performance

At the pretest, there was no significant multivariate difference on performance indicators among the groups. This result is of particular interest in conjunction with the presence of significant differences between groups on indicators provided by standardized achievement tests (see above). Although the control group might have performed better before, at the time of entry to the study, both groups performed approximately at the same level.

Demographic Characteristics

The demographics of the triarchic and control groups were similar in gender composition. Specifically, there was no significant difference in numbers of boys and girls in the study groups. However, the groups differed in ethnic background composition (χ_4^2=12.6, p<.01): Hispanic American children and children of other ethnic backgrounds were under-represented in the control and over-represented in the triarchic group, whereas European American children were over-represented in the control and under-represented in the triarchic group.

Both demographic variables (*Gender* and *Ethnic Background*) were examined via multivariate analysis in association with the baseline dependent measures. There was an effect of *Ethnic Background*: Pillai's Trace=.047, $F_{9,1734}$=3.1, p<.001, with univariate effects significant for all 3 performance indicators. There was no multivariate effect of *Gender* or *Gender* x *Ethnic Background* on the performance indicators, but the interaction effects were significant for 2 variables (memory-analytical and creative). Therefore, we decided to keep both variables in the models for pretest-posttest comparisons.

Pretest-posttest Comparisons

Following the recommendation of Campbell and Kenny (1999), repeated-measures analysis of variance was employed to quantify the differences between pretest and posttest performance of students in the two groups.[11] This data-analytic approach allows for better control for the artifact of the regression to the mean, than the more

traditional approach of utilizing pretest scores as covariates in all contrasts of posttest group differences. The model specified two repeated factors: (a) *Time* (pre versus posttest) and (b) *Type* (3 types of assessments—memory-analytical, creative, and practical). In addition, based on the information obtained through the analysis of the baseline differences, the linear models included the between subject factor of *Group* (triarchic versus control) and a number of covariates (*Degrees of Reading Power (DRP)*, *Holistic Writing*, *Gender*, *Ethnic Background,* and *Year of Study*). Thus, the main effect of interest was that of the interaction between *Time* and *Group* (i.e., whether the difference between performance on pre and posttest assessments varied across the triarchic and control groups). Additional within-subjects effects of interest were the effects of *Type* and all interactive effects between the repeated factors and covariates. In addition, the between-subjects effects of all covariates were evaluated.

Table 2.1 shows the observed means for boys and girls of various ethnic backgrounds in the two different teaching groups (triarchic and control). The analysis produced a number of significant results. We will start with the report of within-subject effects.

First, and most interestingly, the results showed a significant *Time x Group* effect (Pillai's Trace=.021, $F_{1,579}$=12.3, p<.001, ξ^2=.021), indicating a statistically significant difference in the profiles of performance scores changes over time in the two study groups (triarchic and control). Students in the triarchic condition excelled on the tasks of all three types—memory-analytical (t_{449}=-4.5, p<.001), practical (t_{449}=-10.9, p<.001), and creative (t_{449}=-3.5, p<.001). For comparison, the time profiles of the performance in the control group look very different—the students remained approximately at the same level of performance on memory-analytical tasks (t_{254}=1.6, p>.05), improved on the practical tasks (t_{254}=-5.0, p<.001), and slightly declined on creative tasks (t_{254}=3.5, p<.001). This decline should be interpreted with caution—it is possible that it is only a random fluctuation, but it is also possible that it indicates that traditional classrooms inadvertently tend to suppress creativity rather than encourage it. Yet another indicator of the change in reading performance introduced by the triarchic teaching is the difference in the patterns of correlations between pre and posttest scores in the study groups. Specifically, in the control group, the pretest scores predicted the posttest scores more effectively than in the triarchic group—that is, all control group correlations were statistically higher than the respective triarchic group correlations (ρ=.61, ρ=.59, ρ=.55 versus ρ=.30, ρ=.35, ρ=.46 [p<.001 for all] for memory-analytical, practical, and creative in the control and triarchic groups, respectively).

Second, the performance on different types of tasks differed in terms of their absolute values, with the highest scores observed for practical tasks, the second-highest, for memory-analytical tasks, and the lowest—for creative tasks (Pillai's Trace=.11, $F_{2,578}$=36.9, p<.001, ξ^2=.113). In addition, the three types of tasks showed different patterns over time so that the highest gains over time were obtained for practical tasks and the lowest—for creative, with the memory-analytical tasks in between (Pillai's Trace=.015, $F_{2,578}$=4.5, p<.01, ξ^2=.015).

Table 2.1

The Curriculum-based Middle School Study: Observed Performance Scores' Means and Standard Deviations (Grouped by Group, Gender, and Ethnic Background)

Performance Indicators	Gender	Pretest					Posttest				
		Ethnic Background					Ethnic Background				
		AA Mean (*SD*)	HA Mean (*SD*)	O Mean (*SD*)	EA Mean (*SD*)	Total Mean (*SD*)	AA Mean (*SD*)	HA Mean (*SD*)	O Mean (*SD*)	EA Mean (*SD*)	Total Mean (*SD*)
		Triarchic Group									
Analytical	Boys	16.3(4.3)	17.7(3.4)	17.7(4.4)	17.5(4.5)		17.7(4.5)	17.9(4.5)	18.1(5.4)	17.1(4.2)	
	Girls	17.6(4.0)	16.9(4.7)	16.4(4.6)	18.6(4.5)		18.4(3.8)	17.3(4.1)	19.7(3.2)	20.7(3.0)	
	Total					17.2(4.3)					18.1(4.2)
Practical	Boys	17.1(4.0)	18.0(3.5)	17.1(4.6)	19.5(4.4)		19.4(3.2)	19.3(3.3)	19.6(3.1)	19.6(2.1)	
	Girls	17.4(3.6)	18.0(4.1)	17.9(3.9)	19.1(3.7)		19.8(2.7)	19.2(3.7)	20.1(2.9)	21.5(2.2)	
	Total					17.7(3.9)					19.6(3.1)
Creative	Boys	10.8(5.6)	12.7(5.5)	12.9(7.8)	11.8(7.6)		11.7(5.1)	13.0(4.4)	14.3(4.8)	11.9(3.3)	
	Girls	12.4(5.3)	11.7(5.7)	13.6(5.5)	14.1(7.2)		13.0(4.2)	12.2(5.1)	13.9(4.1)	16.6(6.1)	
	Total					12.2(5.9)					12.9(4.8)
		Control Group									
Analytical	Boys	13.8(5.3)	14.9(5.6)	15.1(4.3)	19.4(4.0)		13.4(5.9)	13.3(5.4)	15.9(7.5)	18.5(4.2)	
	Girls	16.7(4.0)	16.4(5.3)	18.3(3.0)	18.2(5.0)		16.1(5.0)	17.3(5.1)	16.1(6.7)	19.7(6.0)	
	Total					16.0(4.9)					15.5(5.8)
Practical	Boys	14.0(5.3)	15.8(4.9)	17.4(4.4)	19.8(4.0)		15.5(4.5)	15.6(5.7)	20.4(2.6)	20.5(4.3)	
	Girls	17.0(5.1)	17.3(5.3)	19.0(3.3)	19.5(4.7)		18.1(4.5)	18.3(4.9)	20.2(4.2)	20.0(4.2)	
	Total					16.5(5.2)					17.7(4.8)
Creative	Boys	8.4(5.4)	11.4(6.7)	12.3(6.9)	17.3(6.7)		8.1(5.3)	9.5(4.4)	10.4(5.8)	14.9(4.9)	
	Girls	14.2(5.3)	12.9(5.6)	14.2(7.7)	15.0(7.3)		10.7(4.7)	11.2(5.7)	13.1(4.7)	14.2(8.1)	
	Total					12.3(6.4)					10.5(5.5)

Notes. [1]AA—African American; HA—Hispanic American; EA—European American; O—Other.

[2]The means and *SD*(s) are obtained on scores aggregating items administered for pretest (2) and posttest (2) stories in two (vocabulary and comprehension) assessments. Thus, each component of the pretest assessment included 24 items (6 vocabulary and 6 comprehension items for 2 stories), defining the possible range of answers as 0–24.

Third, the CMT standardized scores on the reading test (*DRP*) appeared to differentiate the impact of the program over time (Pillai's Trace=.031, $F_{1,579}$=18.8, p<.001, ξ^2=.031), for different tasks (Pillai's Trace=.045, $F_{2,578}$=13.5, p<.001, ξ^2=.045), and for the *Time x Type* interaction effect (Pillai's Trace=.020, $F_{2,578}$=5.8, p<.001, ξ^2=.020). To investigate the role of *DRPs* in the time changes in the performance scores of various types (memory-analytical, practical, and creative), we calculated the posttest-to-pretest difference scores and, based on these scores, divided the sample into three groups (separate for scores on memory-analytical, practical, and creative tasks): gainers (those students, whose difference score was above the 75th percentile), decliners (those, whose difference score was below the 25th percentile), and steady-staters (those, whose scores were within the 25-75th percentile range). Then we compared performance scores in these three groups. For memory-analytical tasks, there was a statistically significant difference in *DRP* scores among gainers, steady-staters, and decliners ($F_{2,698}$=5.9, p<.01). Specifically, the highest *DRP* scores were characteristic of steady-staters (39.09), with gainers and decliners far behind, but in close proximity to each other (35.8 and 36.6, respectively). For practical tasks, higher *DRPs* were characteristic of both decliners (39.2) and steady-staters (38.8), and gainers, once again, demonstrated significantly lower scores (34.4) *DRPs* ($F_{2,698}$=11.6, p<.001). Finally, for creative tasks, gainers showed the lowest *DRPs* (34.5), with both steady-staters and decliners showing *DRP* scores that were significantly higher ($F_{2,698}$=10.5, p<.001) than those of gainers, but statistically not different from each other (37.9 and 40.0, respectively). Thus, students who benefited from the program the most, tended to have somewhat lower *DRPs*. The highest *DRPs* were characteristic of decliners on practical and creative tasks, and of steady-staters on memory-analytical tasks.

Finally, the last group of within-subject interactive effects included the variable of *Year of Study*. First, the time dynamics varied for students who participated in the study in Year 1 and for those who participated in the study in Year 2 (Pillai's Trace=.014, $F_{2,579}$=8.2, p<.001, ξ^2=.014). Specifically, in Year 1, there were more than expected steady-staters and fewer than expected gainers for practical tasks (ϕ=.092, p<.05), and more than expected decliners and fewer than expected gainers for creative tasks (ϕ=.202, p<.001). Second, there were differences in performance on different types of tasks (Pillai's Trace=.060, $F_{2,578}$=23.2, p<.001, ξ^2=.039). In addition, there was a significant *Time x Type x Year of Study* interaction (Pillai's Trace=.019, $F_{2,579}$=5.7, p<.01, ξ^2=.019), demonstrating that the time trajectories for different types of tasks differed for Years 1 and 2.

The analyses also revealed a set of between-subject effects. First, there was an effect of *Gender* ($F_{1,579}$=12.5, p<.001, ξ^2=.021), indicating that girls' performance was slightly different from that of boys. Second, there was an effect of *Ethnic Background* ($F_{1,579}$=7.7, p<.01, ξ^2=.013), demonstrating that different ethnic groups performed differently. Third, there was an effect of *Group* ($F_{1,579}$=52.5, p<.001, ξ^2=.083), indicating different levels of performance in triarchic and control groups. Table 2.1 shows mean values corresponding to these effects. Fourth, there was an effect of *DRP* (students with higher *DRP* scores tended to perform better (pretest: $\rho_{analytical}$=.38, $\rho_{practical}$=.43, $\rho_{creative}$=.47 and posttest: $\rho_{analytical}$=.42, $\rho_{practical}$=.28, $\rho_{creative}$=.36 [p<.001 for all]). Fifth, there was an

effect of *Holistic Writing* (students with higher levels of writing proficiency demonstrated higher levels of performance (pretest: $\rho_{analytical}$=.18, $\rho_{practical}$=.20, $\rho_{creative}$=.25 and posttest: $\rho_{analytical}$=.19, $\rho_{practical}$=.15, $\rho_{creative}$=.20 [p<.001 for all]). Finally, there was an effect of *Year of Study* ($F_{1,579}$=4.5, p<.05, ξ^2=.008). Specifically, the Year 1 sample performed better on the pretest creative task ($F_{1,707}$=24.4, p<.001, 13.2 versus 10.9, for Year 1 and Year 2, respectively), whereas the Year 2 sample performed better on the posttest memory-analytical ($F_{1,707}$=6.0, p<.05, 16.6 versus 17.5, for Year 1 and Year 2, respectively) and on the posttest practical ($F_{1,707}$=6.3, p<.05, 18.5 versus 19.3, for Year 1 and Year 2, respectively).

To summarize, the analyses showed that training has a significant impact on performance scores over time whereby students taught triarchically profit more over time from instruction than do students not taught triarchically. In addition, all variables in the equation were found to impact the performance scores. Of most importance was the impact of the standardized reading achievement indicator (*DRP*). This variable predicted both (a) the levels of performance on the task (so that children with higher *DRP* scores demonstrated better performance) and (b) the susceptibility to the triarchic intervention (children who gained from the program the most tended to demonstrated lower *DRP* scores). Moreover, even though there were some nonsystematic differences in performance in children from Years 1 and 2 of the study (e.g., for practical and creative tasks, there were more gainers in Year 2 than in Year 1), children in the triarchic group in both years advanced more than their peers in the control group. Finally, the variables of *Gender, Ethnic Background,* and *Holistic Writing* all accounted for significant portions of variance in the performance scores, but did not show differential links with either the time factor (i.e., boys and girls of all ethnic backgrounds at all levels of writing abilities benefited equally from the project) or the type of the task (i.e., neither boys nor girls of any specific ethnic background showed differential improvement for a particular type of tasks—memory-analytical, creative, or practical).

Affective Indicators

To evaluate the affective aspect of the program, we asked teachers and students from the triarchic group to provide an affective view of the program.

Teachers

On a 7-point scale where 1 was low and 7 was high, teachers rated the interestingness of the program to them at 6.3 and the interestingness of the program to the students at 5.6. They rated the level at which it motivated them at 6.1 and the level at which it motivated their students at 5.7. In addition, the teachers thought that the triarchic teaching strategies addressed the needs of students with various levels of skills (6.0) and that the program was inclusive of a wide range of children as indicated by a rating of 5.9.

Students

Students were also asked how they liked the program. We found that 36.4% of the children indicated they liked the program very much; 44.4% liked it; 12.1% did not feel one way or another; and only 7.1% disliked it.

The Stand-alone Program of the Summerbridge Study

The main objective of the Stand-alone Program of the Summerbridge Study was to develop a stand-alone triarchic reading curriculum for an academic summer program in a low SES urban school district. This program was developed for two fiction books recommended as supplementary reading in upper middle school grades. The program's goals were to select a high-achieving group of students from an urban school district, assess the students' reading skills using a pretest based on grade-appropriate reading material (developed on the basis of commercial textbooks for seventh grade), randomly divide the group into two subgroups, teach one group triarchically for a duration of 6 weeks, and then reassess reading skills in the whole group. In other words, the main purpose of the Stand-alone Program of the Summerbridge Study was to investigate whether a 6-week triarchic reading program can significantly improve reading performance and what the dynamics of this improvement were.

Thus, in terms of the specific differences between the Stand-alone Program of the Summerbridge Study and our other studies, this research (a) attempted to improve children's reading skills by building vocabulary and enhancing comprehension skills, (b) relied exclusively on supplementary reading material and, therefore, formed a stand-alone program, (c) included a population of low SES, inner-city, ethnically diverse sixth graders achieving at higher-than-average level, and (d) implied a test of the generalizability of triarchic instruction by administering the instruction as a stand-alone program.

Method

Participants

All students in this summer program were from the lower regions of the socioeconomic spectrum. The selection procedure for the program was based on academic records (the applicants were required to provide teacher recommendations and to have high middle school grades) and SES eligibility (the program is designed for low SES students). A sample of 62 students admitted to the Summerbridge Program in 1998 was randomly divided into the two groups. There were 33 students in the experimental group and 29 students in the control group. The understanding was that experimental students would take the program in the summer of 1998, and the rest (the control students) would take the program in the summer of 1999 (after the experiment ended).

These seventh grade samples can be broken down further in terms of their composition. First, consider gender. Of the 33 students in the 1998 summer program, 21 were girls and 12 were boys. Of the 29 students in the control group, 14 were girls and 15 were boys. Second, consider ethnic group. Of the 33 experimental group children, 28 were African American, 3 were Hispanic American, and 2 were Caucasian. Of the 29 control group children, 23 were African American and 6 were Hispanic American.

Materials[12]

Assessment Materials

Assessment materials comprised a pretest and a posttest. The pretest involved six excerpts from various seventh grade textbook materials. Two excerpts, however, were different in format from those presented in the posttest (one was an excerpt from a play, and the other—a piece of poetry). Therefore, for comparability, only four parallel pretest excerpts were kept. The posttest involved four such excerpts. Each excerpt was followed by six questions, two of which were multiple-choice and four of which were open-ended. In all, two of these questions emphasized assessment of memory-analytical skills, two emphasized assessment of creative skills, and two emphasized assessment of practical skills.

As an example, consider one excerpt plus the memory-analytical, creative, and practical questions associated with it.

> From "Hints from a Wildlife Watcher" by Jim Arnosky:
>
> Getting Close to Animals
>
> Wild animals are sensitive to everything around them. Stalking them takes practice and patience. In reptiles, fish, and mammals, the sense of smell is acute. A snake depends on its sense of smell to locate food and detect danger. A salmon can smell a bear in the water a mile upstream. A fox can sniff a rabbit's scent in tracks that are days old.
>
> Wherever you go you leave some of your scent in tiny particles (pieces of matter) that are released from your body and clothing. These particles fall to the ground as you move. They cling to vegetation. They float in the air and drift to surrounding areas. Often your scent reaches an animal long before you do, which scares it away. When you see a wild animal, stay downwind. This will keep your scent in back of you and away from the animal you are watching.
>
> Most animals can hear as well as they can smell. Even snakes, fish, and others deaf to airborne sounds can feel noises vibrating through the ground. When stalking wildlife, be as quiet as possible. Step softly. Try not to scrape against trees or brush. If you must make a sound, do so when the animal you are watching is busy chewing food, shifting position, or moving to a new spot. It will

make noises of its own and may not notice yours. If you are heard and the animal becomes alert—freeze in your tracks!

Keep still and most animals will not see you, even if you are out in the open. In general, animals look out for movements. Many animals, including most mammals, see only in shades of gray. A motionless figure is difficult for them to single out of a scene. Sometimes the shape of a standing human, still or moving, will frighten them. You can disguise your human shape simply by crouching down.[13]

1. The author's main purpose in writing this article is to

a) describe the wonder of wildlife.
b) relate his personal experiences.
c) prove that wildlife watching is superior to hunting.
d) explain how creatures detect humans and how humans can best approach wildlife.

2. What did you learn from this passage about animals' ability to see?

_____

3. Suppose after reading this passage you want to learn more about watching birds, in particular. Which of the following would probably be the LEAST USEFUL thing to do?

a) Check out books on bird-watching from the library
b) Talk to the bird expert at the local nature preserve
c) Watch a Discovery program about sea creatures
d) Join a bird-watching club

4. Based on what you learned from this passage, what would you do if you spotted a deer in the woods and wanted to watch it without scaring it away?

_____

5. Pretend that you are a snake lying on a path, and a person is approaching. Briefly describe one or two thoughts that you (the snake!) might have.

_____

6. Think for a moment about the subjects you know something about (playing a particular sport, playing a musical instrument, painting houses, or whatever). Pretend that you are going to write a "how-to" article on one of those topics. What would be a descriptive and catchy title for your article?

_____

Instructional Materials

The instructional materials for the course were two novels: *A Raisin in the Sun*[14] by Lorraine Hansberry, and *The Lottery Rose*[15] by Irene Hunt.

Examples of activities for the various days are as follows:

Analytical

Discussing the Reading

Discuss and analyze the reading. Exact content will vary, depending on how far in the novel the students have read at this point and what their particular interests and problems were. Some aspects to cover: . . . .

Discuss societal issues. Get them to talk about what this screenplay reveals about African American life in the middle of the twentieth century. What have they learned about job opportunities for African Americans at this point in our nation's history? Are things different today or not? And so on.

Creative

Creating Environments

Begin with a brief recap discussion of the many emotions that Georgie experiences during the first four chapters of the book. Ask the students to list them. Jot the students' suggestions down on the board. Some possibilities are anger, embarrassment, anxiety, anticipation, joy, terror, disappointment. Tell the students that today they are going to invent scenarios that capture these emotional states. This can be either an individual or a small-group exercise. Assign each person or group a particular emotional state (see list above for some examples) without letting the rest of the class know what that individual or group's assigned emotion is. Instruct the students to think of a situation (not one in the book) in which a person would experience . . . [his/her] assigned emotion. Their task is to describe that situation in a way that makes the emotional state clear and vivid. They can write a descriptive scenario. (They could also invent a monologue, compose a song, make up and act out a group skit, etc. You can allow them as much, or as little, leeway as you'd like as far as the form is concerned.) They should concentrate on effective expression rather than length. One rule you should give them is that they cannot identify the emotional state in words. (In other words, if they are supposed to be evoking sadness, they should not use the word *sad* or *sadness*.) Encourage them to choose their words carefully to produce the desired effect and "show rather than tell"—that is, they should try to paint a picture with words, rather than simply "report" an emotion or event.

Practical

What to do with the Money: Debate and Persuasion

Staging a Debate: By now, the students should grasp that one of the central dilemmas of the book is what Mrs. Younger should do with her newfound wealth. Tell the students that they are going to have a chance to exercise their powers of persuasion by participating in a debate on this subject. There are various ways a debate like this could be structured. Here is one idea:

Small-Group Meetings: Divide the students into three small groups (the same ones they are already in, or new ones, if you prefer). You could explain to them that each group is the representative (or agent, or lawyer, or spokesperson, or whichever term you think the students would identify with the most) for one of the following characters: Walter, Beneatha, and Ruth. Each group should prepare for the debate by discussing among themselves what their character wants done with the money and why. The group members should also come up with some arguments in favor of their own plan for the money—so that they can support their assertions. They also might want to try to anticipate how other teams will argue against them, and how they might want to undercut the other teams' claims on the money.

Students did homework and took quizzes on each of the works.

Design

Participants were randomly assigned to the experimental and control groups, resulting in a true experimental design. The main dependent variable (outcome measure) was the indicator of gain from the pretest to the posttest scores. The main independent variable (predictor measure) was group assignment. In addition, the performance of the Summerbridge students was evaluated longitudinally, through five sets of vocabulary and comprehension assignments. Gender and ethnic-group differences also were analyzed, but no significant differences were obtained.

Procedure

Teacher Training

Summerbridge teachers were invited to participate in a two-part workshop, of which the first part was dedicated to triarchic instruction and assessment (i.e., how to teach and assess analytically, creatively, and practically) and the second part to general issues of teaching reading in middle school.

Student Participation

Students spent 3 weeks on each book, for a total of 6 weeks. The material from each novel was divided into three equal parts, to be covered at the rate of one part per

week. Children were expected to use weekends to do much of their reading. Mondays typically were devoted to reading aloud, review, and other activities, to ensure that students had read and understood the basics of the reading assignment. Homework assignments also were due on this day. Tuesday, Wednesday, and Thursday were each targeted for primarily analytical, creative, or practical activities, with different orders of activities in different weeks. Friday was an assessment day, involving both reading comprehension and vocabulary. During the last week of the program, teachers were given some flexibility to introduce freely additional relevant activities of their own.

Similar to the procedure in the Curriculum-based Middle School Study, the teachers used the assessments for their purposes and then turned them in, so that they could be scored by two independent raters blind to the conditions of the study. The scoring was based on the same principles as those described in the Curriculum-based Middle School Study.[16] Inter-rater reliabilities ranged from .73 to .95 (median: .84).

Results and Discussion

In the Stand-alone Program of the Summerbridge Study, we performed two different types of analyses. First, we investigated whether the Summerbridge program had an effect on the reading performance of children who attended the program as compared to the performance of children who were not enrolled in the program. Second, we investigated the patterns of the performance of the Summerbridge students on intermediate assessments (i.e., the assessments administered between the pre and posttest).

Baseline Differences in Performance

At the pretest, there was no significant multivariate difference on performance indicators among the groups.

Demographic Characteristics

There were no significant multivariate difference on pre and posttest performance indicators among boys and girls of different ethnic backgrounds.

Pretest-posttest Comparisons

The data in Table 2.2, showing the observed means for the two groups, were analyzed using a method similar to that presented in the description of the Curriculum-based Middle School Study. Specifically, repeated-measures analysis of variance was employed, where two within-subject factors were specified: the *Time* factors (with two levels, pretest and posttest) and the *Type* factor (with three levels, memory-analytical, practical, and creative).

Table 2.2

The Stand-alone Program of the Summerbridge Study: Pretest and Posttest Observed Means and Standard Deviations

Performance Indicators	Pretest		Posttest	
	Triarchic Mean (*SD*)	Control Mean (*SD*)	Triarchic Mean (*SD*)	Control Mean (*SD*)
Analytical	4.6 (2.27)	4.4 (1.96)	5.2 (1.82)	4.3 (1.45)
Practical	4.9 (2.04)	4.1 (2.12)	6.5 (1.55)	4.9 (1.67)
Creative	4.1 (2.47)	3.4 (1.97)	5.4 (1.93)	3.0 (2.13)

Note. Altogether, there were 24 pretest and 24 posttest items. Both at pretest and posttest, there were 8 memory-analytical, 8 practical, and 8 creative items. Thus, the possible range of values for each entry of Table 2.2 is 0-8.

The analysis revealed a number of significant results. First, of most interest was the *Time x Group* interaction effect (Pillai's Trace=.15 and $F_{1,59}$=10.6, p<.01). This effect implies that the pre-to-posttest changes in the two groups were statistically significantly different from each other. Specifically, although there were no differences at the baseline, the triarchic group outperformed the control group on all three posttest indicators (t_{60}=2.1, p<.05, t_{60}=3.9, p<.001, and t_{60}=4.4, p<.001, for memory-analytical, practical, and creative items, respectively), improving significantly more than did the control group. Second, there was a significant effect of *Time*, suggesting that performance at pretest was, overall, significantly different from performance at posttest (Pillai's Trace=.21 and $F_{1,59}$=15.8, p<.001). (The time changes are shown in Table 2.2.) Third, the main effect of *Type* (Pillai's Trace=.42 and $F_{1,59}$=20.6, p<.001) implied that the analyzed profiles were different for memory-analytical, practical, and creative tasks. Specifically, as is shown in Table 2.2, the highest level of performance in both groups was on practical tasks, and the lowest—on creative tasks. Fourth, the *Type x Group* interaction (Pillai's Trace=.14 and $F_{1,58}$=4.5, p<.05) showed that the profiles of performance on memory-analytical, practical, and creative tasks were different in the two groups. Finally, the *Time x Type* interaction (Pillai's Trace=.32 and $F_{1,58}$=13.5, p<.001) was also significant, illustrating the differences in the dynamics of time changes for different types of tasks. In particular, whereas both groups improved their performance on practical tasks (t_{28}=-2.6, p<.05 and t_{32}=-6.4, p<.001, for control and triarchic groups, respectively), the triarchic group improved its scores on both analytical (not significant) and creative tasks (t_{31}=-3.2, p<.01), whereas the control group's performance on these tasks dropped slightly (not significant).

In sum, in the Stand-alone Program of the Summerbridge Study we generally have replicated the pattern of findings reported in Study 1: The triarchic group benefited significantly more over time from instruction than did the control group.[17] In this study,

there was no effect of demographic variables (e.g., gender and ethnic background), but, in part, the absence of group differences might be explained by the small *N*.

Relations of In-class With Formal Assessments

One would want to ensure that the pretest and the posttest were related to the assessments that were part and parcel of the program. Such insurance should confirm that both tests do in fact measure whatever it is the program is supposed to be teaching, and that the dynamics of the change in the in-class assessments' scores explain, at least partially, the observed gains on the posttest.

First, we calculated a set of Spearman's correlations, linking the combined vocabulary and comprehension scores to the pre and posttests. For memory-analytical tasks, the median correlations between the in-class assessments and the formal testing were .34 ($p<.05$) and .37 ($p<.05$), for pretest and posttest, respectively. Out of 10 correlations screened, four were not significant. For the practical assessments, 7 of 10 correlations were statistically significant. The median correlations between in-class assessments and pre and posttest indicators were .35 ($p<.05$) and .45 ($p<.01$), respectively. For the creative assessments, 5 of 20 correlations were statistically significant, with the median correlations between in-class assessment and pre and posttest indicators of .31 (ns) and .38 ($p<.05$). Thus, there is a relation between the performance on the in-class assessments and the performance on the pre and posttest.

Second, we were interested in investigating the changes in the in-class assessments during the Summerbridge period. To investigate this issue, we conducted a repeated-measured analysis of variance on a set of five assessments (3 per set—memory-analytical, creative, and practical) collected throughout the program. Similar to the pre and posttest analysis, the model had two within-subject factors, *Time* and *Type*. The analysis revealed a significant effect of *Time* (Pillai's Trace=.53 and $F_{4,29}=8.3$, $p<.001$); the contrast analysis revealed that the changes in the performance were of quadratic nature ($F_{1,32}=25.3$, $p<.001$) in the performance indicators. Specifically, students' performance improved significantly on memory-analytical and practical indicators after 2 weeks of instruction ($t_{32}=-3.2$, $p<.01$ and $t_{32}=-3.2$, $p<.01$, for memory-analytical and practical indicators, respectively), but the improvement on creative items did not reach the level of statistical significance. This specificity of profiles for memory-analytical, practical, and creative tasks was also captured by the effect of *Type* (Pillai's Trace=.67 and $F_{4,29}=32.1$, $p<.001$), indicating the differential dynamic of performance for different types of tasks (e.g., the group's performance on memory-analytical and practical was much higher than that on creative tasks).

To summarize, the triarchically enhanced Summerbridge program had a statistically significant effect on the memory-analytical, practical, and creative assessments at posttest (as compared to the control group). The Summerbridge students improved their performance from pretest to posttest on all types of tasks; however, the improvement reached the level of statistical significance on the practical and creative tasks but not on the memory-analytical tasks.

The Curriculum-based High School Study

The main objective of the Curriculum-based High School Study was to investigate ways and benefits of incorporating triarchic instruction into teaching in a variety of subject areas. The Curriculum-based High School Study was conducted in three public high schools in urban districts in the subjects of mathematics, physical sciences, social sciences, English, history, foreign languages, and the arts. Having observed the benefits of triarchic instruction in one subject area, can we expect to see comparable gains in comprehension and vocabulary skills applied to multiple subject matter areas?

Thus, the main innovation of the Curriculum-based High School Study as compared to other studies conducted within the triarchic approach to teaching was to blend triarchic instruction into different subject areas. Moreover, this intervention was designed to be relatively short-term. Specifically, we wanted to verify the hypothesis that triarchic teaching would have an impact on students' performance—even when the intervention was relatively short. As in our previous work, we concentrated on reading for comprehension and vocabulary development, limited instructional modifications to changing existing curriculum materials, conducted the work in at-risk urban areas, closely worked with teachers, and administered the intervention to a considerable sample of students. In addition, we wanted to investigate the patterns of performance improvement: Do some students improve in one domain and not the other, or do they improve in all domains?

Method

Participants

The participants in the Curriculum-based High School Study were high school students attending grades 10 through 12 in high schools in New Haven and Ansonia, Connecticut. A total of 432 students (130 females, 215 males, and 87 of unreported gender) participated in the study. Of these students, 201 (46.5%) were attending schools enrolled in the triarchic group (two New Haven schools) and 231 were attending the control school (in Ansonia). At the schools' request, information on ethnicity of students and their standardized tests achievement scores was not collected. The pretest and posttest were administered during students' preparation for the Connecticut Mastery Test.

A subset of this sample was enrolled in the triarchic intervention study. This subsample included 99 students in the triarchic group and 100 students in the control group. Of these students, 110 were male (55.3%) and 89 (44.7%) were female. The students in the triarchic group were enrolled through their teachers. The students in the control group were selected at random.

The teachers in the triarchic group taught arts, English, social sciences, French, physical science, and history. Thus, the overall goal of the program was to verify whether triarchically-enhanced instruction based on commercial textbooks in a variety of

subject matters would improve students' performance as compared with traditional instruction based on same commercial textbooks.

Materials

Assessment Materials

Common pre and posttests were developed for the control and experimental groups. Both assessments contained 10 subject-specific paragraphs (e.g., mathematics excerpts, physical sciences excerpts, history excerpts), approximately 150 words long. Each paragraph was followed by three questions, assessing vocabulary knowledge and comprehension skills. The first comprehension question could be answered based on the information provided by the text. The second comprehension question necessitated linking the information contained in the text to prior knowledge. The format of the questions was either multiple-choice or open-ended, attributed at random. Also attributed at random was the ability (memory-analytical, practical, or creative) assessed. There were 10 memory-analytical, 10 practical, and 10 creative items. Below are some examples of actual materials used to assess readers' analytical, creative, and practical vocabulary and comprehension skills.

Analytical

An important analytical vocabulary skill is to understand the meaning of a given word when presented in a natural reading context. Asking the student to compare and contrast two or more concepts typically assesses analytical comprehension skills. For example, students were given the following Arts paragraph to read:

> The colors of Alan Stocker's paintings are very beautiful. The subject matter is shocking and disturbing. His large canvases are painted all over, edge to edge, with intricate, swarming forms. Some are in rich reds, golds, and umbers. Some have patches of scarlet, deep purple, a kind of muted turquoise, touches of sky-blue or airforce blue. Some are simple expanses of a feminine pink or a delicious silvery, smoky gray. From a distance, the paint has the busy brilliance and depth of a painting by Jackson Pollock. When you come nearer, you see that the whole surface is made up of forms—birds, beasts, men, monsters, demons, and broken bits of birds, beasts, and humans—which are painted in all sorts of sizes. Take *Consequence of Solitude*, for example, a large canvas in hot infernal reds, mixed with pitchy shining blacks and ochres on a background like burned pale clay. Large forms loom in it: a great mad face on a childish body which runs into a kind of goat, llama or camel, with a silly grin and rich crimson trappings, ridden by a horned demon of a conventional sort, in profile; a kind of witch flies towards these on a collision course, and below her a half-creature with a bulbous head and delicate arms is poised to fly or dive.
>
> Analytical vocabulary skills were assessed with the following question:

Intricate most likely means

a) entangled.
b) simple.
c) invisible.
d) rational.

Analytical comprehension skills were assessed with the following question:

Compare and contrast the distinct features of Stocker's paintings with the distinct features of any other painter you know.

Creative

An important creative vocabulary skill is to go beyond merely understanding the meaning of the word and actually to invent a sentence containing the given word. The following example illustrates how creative vocabulary and comprehension skills can be assessed. Students were given this biology and physical sciences paragraph to read:

> Normal human cells are mortal. After they divide 50 to 100 times, they get old. Or, as scientist put it, they senesce. Senescent cells are bigger than young cells, excrete proteins at a different rate, and no longer divide. A year ago, a team of biomedical researchers announced that they had discovered a way to prevent cells from aging. They took skin cells and added a gene that causes cells to produce an enzyme called telomerase. Normally, foreskin cells divide about 60 times before becoming senescent. But in the researchers' experiments, the cells have already divided more than 300 times and show no sign of stopping at all. Nor do they show any sign of abnormality. Researchers, though hopeful, don't yet know whether this method for putting cellular aging on hold will eventually be useful in slowing the aging of the human body, so nobody is suggesting that we all start adding telomerase to our corn flakes.

Creative vocabulary skills were assessed with the following statement:

Think of and write a sentence with the word *senescent* in it. (Modified sentences from the paragraph above are not acceptable.)

Creative comprehension skills were assessed with the following question:

Suppose that based on the experiments described above a drug company develops a medication that prevents aging. This company hires you to develop an ad two or three sentences long to go along with a picture of the container of the drug. What would you write?

Practical

An important practical vocabulary skill is to understand what the meaning of a given word signifies practically. Asking the student to apply new knowledge to an everyday situation typically assesses practical comprehension skills. In the following example, students were given this physical sciences paragraph to read:

> In order to furnish a simple method of locating positions on the earth, two sets of lines are drawn on maps of the earth and imagined as drawn on the earth itself to be used as reference lines. The earth is a globe, almost an exactly round ball. The imaginary straight line passing through its center and about or around which it turns as a "shaft" or "axle" is called its axis, and the two ends of this line on the surface of the earth are called the earth's poles. A line drawn around the earth midway between the poles is called the equator, as it divides the earth's surface in two equal parts. The latitudes are parallel to the equator. They are numbered from the equator to each pole, northward and southward, beginning with 0° at the equator and ending with 90° at each pole.
>
> The Greenwich meridian divides the equator into two semi-circles and each longitude is measured eastward and westward from this meridian. Meridians divide the planet into time zones.
>
> Practical vocabulary skills were assessed with the following question:
>
> If you take off from Europe and keep going east, you stop going east and you start going west when you cross
>
> a) the equator.
> b) the Greenwich meridian.
> c) the longitude.
> d) (never).
>
> Practical comprehension skills were assessed with the following question:
>
> Suppose you move 40˚ eastward but stay at the same latitude where you are now. What will be the most apparent difference between the two locations—that is, a difference that will force you to change your daily schedule?

Instructional Materials

At the very beginning of the study, each teacher in the triarchic group submitted a curriculum unit to be taught later on in the semester. The content of these units, covering 4 to 6 weeks of instruction, served as a basis for the materials that were developed. Individually tailored triarchic teacher guides were developed, showing how to teach the content chosen by the teacher so as to call into play and develop students' analytical, creative, and practical abilities. The three categories of abilities represent emphases

rather than discrete categories, since the ultimate aim is to teach students to combine these skills rather than use them separately. For all subject areas, teacher guides focused on subject-specific vocabulary and reading comprehension. Although necessarily different in content from one teacher to another, all the teacher guides were based on the same structure: (a) Introduction, (b) Reading, (c) Vocabulary Activities, and (d) Comprehension Activities.

Each day opened with in introduction during which the teacher established ties between the contents to be taught on that specific day and previously acquired knowledge. The main concepts developed in the day's reading were introduced and students were encouraged to discuss them. A period of either silent or read-aloud reading followed this introduction. The main concept targeted in the reading was always identified and emphasized. Several vocabulary activities related to the reading were offered. These vocabulary activities had four targets: identify new words, teach the meaning of new words, review newly acquired words and their meaning, and apply the newly acquired knowledge. The suggested vocabulary activities were either individual or group activities, with a focus on one of the three abilities (analytical, practical, or creative). Individual and group comprehension activities, focusing on the main concepts developed in the text, were also offered. Again, the suggested activities emphasized on of the three abilities (analytical, practical, or creative). Shown below are samples of actual vocabulary and comprehension activities.

Analytical

An example of an analytical vocabulary activity is to determine the meaning of a given word by analyzing the context in which it is presented. In an art unit on the Impressionist movement, students read the following paragraph and were then asked to explain the meaning of the verb *to render*.

> Impressionism is the name given to a school of painting (. . .) It was "a method of painting that consists in reproducing an impression exactly as it is experienced," and the Impressionist artist "aims at representing objects according to his own personal impressions without bothering about generally recognized rules." The Impressionists painted out of doors, using a technique of separate, fragmented brush strokes and pure prismatic colors; they aimed at rendering changing effects of light and reflection with vivid immediacy and intensity.

Students were then given all the definitions of the word found in a dictionary, as shown below, and were asked to refer to the text in order to determine which one of the definitions best applied in this particular context:

> To render. Verb. (a) To give in return, to give back. (b) To report, as to render an account. (c) To give for use, as to render an account. (d) To invest with qualities, as to render a fortress more secure. (e) To translate from one language to another. (f) To reproduce.

An analytical comprehension activity in this unit on the Impressionist movement in art was to describe a reproduction of a painting by Monet, explaining what features made it characteristic of the Impressionist movement.

Creative

Coming up with sentences using the recently acquired words is a creative vocabulary activity. In a mathematics unit on the power of exponents, students were for example given the following vocabulary task:

> Think of and write a sentence using the word exponentiation.

In this same mathematics unit, students were divided into small groups and given the following comprehension activity, assessing their understanding of the properties and inter-relations of very large numbers:

> On page 398 in the textbook, there is a list of names for very large numbers. Imagine that *Million*, *Billion*, *Trillion*, *Quadrillion*, and *Quintillion* are the characters of a new TV show. List two or three adjectives to describe what each one of them looks like, and describe how they are related to one another. If you want to, you can make a drawing of each character.

Practical

Practical activities encourage students to put into practice what they learn, and think of ways of applying new knowledge in their own lives. In a history unit on *The Heritage of Latin America*, students were asked to apply their new vocabulary knowledge in the following exercise:

> Using the enclosed map of Central and South America, design a trip you would like to take. Draw lines on the map showing how you would travel, and describe your trip using the following words: *Colombia, disembark, embark, expedition, isthmus, Jamaica, Mexico, Panama, Peru, voyage*.

In the same unit, the following group activity assessed students' practical comprehension skills:

> In the mid 1500s, the King of Spain ruled an empire that extended from Mexico to Peru. As you can see on the map it is a very large territory—and very far away from Spain when you can only travel by sail. Imagine that you were the King of Spain in 1550. How would you handle the situation? What would you do to ensure that your power was respected throughout the empire?

Each group then presented its solution to the class, and the students' ideas were compared to historical facts. Student worksheets and vocabulary list were developed to accompany all these activities.

Affective Evaluations

As was the case in the Curriculum-based Middle School Study, affective evaluation forms were offered to evaluate the affective outcomes of the reading program in teachers and students alike. Teachers were asked whether they found the program to be professionally interesting and motivating. In addition, they were asked to evaluate the educational and motivational relevance of the program to their students. Students were asked whether/how much they liked the program and to describe their favorite components of the program.

Design

The critical independent variable in the Curriculum-based High School Study was teaching condition. There were one experimental condition and one control condition. The triarchic intervention was implemented through teachers in different subject areas. The duration of the program was 4 to 6 weeks, and teachers met with students daily for 80-minute periods. Similar to the Curriculum-based Middle School Study, the conditions differed in the methods used for teaching these skills: *triarchic instruction* (experimental) and *conventional (primarily memory-enhanced instruction)* (control). The impact of the triarchic intervention was measured through (a) students' performance assessments and (b) affective evaluations by teachers and students. The performance assessments were administered both before and after the in-service program for the teachers. Thus, it was possible to compare pretest and posttest scores in the experimental versus the control groups.

Procedure

Teacher Training

Teachers in the experimental group were invited to participate in a two-part workshop, of which the first concentrated on triarchic instruction and assessment and the second part addressed general issues of teaching reading for content. Teachers in the control group were offered a one-part workshop on teaching reading for content. The study closed with a round-table discussion carried out by teachers in two separate groups.

Student Participation

Both instructional and assessment materials were administered by teachers. The program started at the beginning of April and ended in late May. To monitor the implementation of the curriculum, all teachers' classrooms were visited randomly at least twice during the intervention stage. The assessment materials were turned in by teachers immediately after they had been administered to students and were graded by teachers for their own purposes. The teachers were asked not to mark the assessments that were turned in. All students' materials were rated by independent raters blind to the study conditions; the procedure was identical to that described in the Curriculum-based Middle School Study.[18] Inter-rater reliabilities ranged from .61 to 1.00 (median: .90). Because

inter-rater reliabilities were so high in previous studies, random cross-ratings by the second rater were only carried out for a third of the materials.

Results and Discussion

The data presented below have been collected on a subsample (199 students[19]) whose teachers participated in the in-service program and who implemented the triarchic curriculum units in their teaching.

Baseline Differences in Performance

At the baseline, the groups were compared by way of pretest assessment performance. There was a significant multivariate difference on performance indicators among the groups (Pillai's Trace=.104, $F_{3,195}$=7.5, p<.001). The subsequent univariate analyses indicated that there was no difference between the levels of performance in the triarchic and control groups on memory-analytical and creative tasks, but the control group performed better than did the experimental group on practical tasks [$F_{1,198}$=12.2, p<.001, ξ^2=.058; $\text{mean}_{\text{control}}$=5.1 ($SD$=2.04) and $\text{mean}_{\text{triarchic}}$=4.0 ($SD$=2.21)]. (See Table 2.3.)

Table 2.3

The Curriculum-based High School Study: Pretest and Posttest Observed Means and Standard Deviations (Grouped by Gender)

Group	Gender	Pretest			Posttest		
		Analytical Mean(*SD*)	Practical Mean(*SD*)	Creative Mean(*SD*)	Analytical Mean(*SD*)	Practical Mean(*SD*)	Creative Mean(*SD*)
Triarchic	Boys	5.5(2.72)	4.5(2.37)	4.6(2.92)	6.0(2.36)	5.7(2.13)	5.7(2.97)
	Girls	4.9(2.33)	3.7(2.02)	3.9(2.40)	5.7(2.50)	6.0(2.07)	5.5(3.02)
	Total	5.1(2.51)	4.0(2.21)	4.2(2.66)	5.8(2.43)	5.9(2.09)	5.6(2.98)
Control	Boys	5.0(2.56)	5.2(2.20)	4.6(2.83)	5.2(2.43)	5.2(2.17)	5.6(2.48)
	Girls	5.3(2.22)	4.9(1.90)	4.8(2.16)	5.0(2.38)	5.5(2.19)	5.0(2.32)
	Total	5.1(2.44)	5.1(2.09)	4.7(2.61)	5.2(2.41)	5.3(2.17)	5.4(2.43)

Note. Altogether, there were 10 pretest and 10 posttest paragraphs to read. Each paragraph was followed by 3 questions. Both at pretest and posttest, there were 10 memory-analytical, 10 practical, and 10 creative items. Thus, the possible range of values for each entry of Table 2.3 is 0-10.

Demographic Characteristics

The effect of gender was examined by multivariate analysis in association with the dependent measures. There was a significant multivariate effect of gender on the performance indicators: Pillai's Trace=.066, $F_{6,191}$=2.2, p<.05. Follow-up univariate analyses, however, revealed only one significant effect—boys performed better on the pretest practical items than did girls [$F_{1,198}$=6.5, p<.01, ξ^2=.032; $mean_{boys}$=4.9 (*SD*=2.29) and $mean_{girls}$=4.2 (*SD*=2.05)]. (See Table 2.3 for details.) Consequently, the variable of gender was included as a covariate in subsequent analyses.

Pretest-posttest Comparisons

Repeated-measures analysis of variance was employed to quantify the differences between pretest and posttest performance of students in the two groups. The observed means and standard deviations for pre and posttest performance indicators are shown in Table 2.3. The main effect of interest was that of the interaction between time and group (i.e., whether the difference between performance on pre and posttest assessments varied across the triarchic and control groups). Additional within-subjects effects of interest were the main effect of time (whether there were statistically significant differences in performance at pre and posttest time points), the main effect of the type of the task (memory-analytical, practical, creative), and the interactions effect between time-based changes in performance, task type and students' gender.

First, and most importantly, the results showed a significant *Time x Group* effect (Pillai's Trace=.042, $F_{1,195}$=8.6, p<.01, ξ^2=.042), indicating a statistically significant difference in the profiles of performance scores' changes over time in the two study groups (triarchic and control). Students in the triarchic condition excelled on the tasks of all three types—memory-analytical (t_{98}=-2.6, p<.01), practical (t_{98}=-7.0, p<.001), and creative (t_{98}=4.0, p<.001). For comparison, the time profiles of the performance in the control group look very different—there were not statistically significant pretest-posttest differences in students' performance on memory-analytical and practical items, but their performance improved on creative items (t_{98}=-2.0, p<.05).

Second, there was a significant effect of *Time* (Pillai's Trace=.118, $F_{1,195}$=26.0, p<.001, ξ^2=.118). Table 2.3 demonstrates that both groups showed pre-to-posttest gains.

Third, the performance on different types of tasks differed in terms of their absolute values, with scores being slightly higher (especially at pretest) for memory-analytical and practical items, and lower for creative items (Pillai's Trace=.038, $F_{2,194}$=3.8, p<.05, ξ^2=.038). In addition, the three types of tasks showed different patterns over time so that the highest gains, in both groups, were obtained for creative items (Pillai's Trace=.065, $F_{2,194}$=6.7, p<.001, ξ^2=.065), with the triarchic group showing gains on various types of tasks in a way that differed from the gains made by the control group (Pillai's Trace=.046, $F_{2,194}$=4.6, p<.05, ξ^2=.046).

The analyses revealed the absence of between-subject effects. In other words, there was no main effect caused by group or gender.

Thus, significant effects were obtained for all performance indicators, suggesting that even a relatively short intervention could produce significant effects.

To summarize,[20] the analyses showed that training has a significant impact on the performance scores. Specifically, students who were taught through triarchic methodologies benefited more from instruction than did students who were taught in more conventional ways.

Patterns of Performance Improvement

To explore patterns of improvement across different domains of performance (memory-analytical, practical, and creative), we used a procedure similar to that of the Curriculum-based Middle School Study. The sample was divided into three groups (separate for scores on memory-analytical, practical, and creative tasks): gainers (those students, whose difference score was above the 75th percentile), decliners (those, whose difference score was below the 25th percentile), and steady-staters (those, whose scores were within the 25-75th percentile range). We then compared patterns of pre-to-posttest changes in these groups across three types of tasks (memory-analytical, practical, and creative).

The 3 x 3 x 3 contingency table (the pattern of change-by-different types of tasks) was subjected to log-linear analysis. Our goal was to explore the clustering of change across different types of items. We started the analysis by fitting the independence model, assuming that the patterns of change (gain vs. loss vs. stability) were independent from each other for different types of items. This model did not fit ($\chi^2_{20}=70.4, p<.001$), suggesting that the observed changes were not independent of each other, that is, that changes in one domain were linked to changes in at least one other domain. Then, we attempted to fit three different models, specifying three main-effects and one interaction (e.g., main effects for memory-analytical, practical, and creative, and creative-by-practical interaction). None of these models fit the data ($\chi^2_{16\ (C,\ AxP)}=31.3, p<.01$; $\chi^2_{16\ (P,\ AxC)}=48.7, p<.001$; and $\chi^2_{16\ (A,\ CxP)}=60.7, p < .001$), suggesting that patterns of change in one domain were linked to changes in the other two domains. To verify this hypothesis, we fit a series of models depicting three main effects and two one-way interaction effects. Two models did not fit ($\chi^2_{12\ (PxC,\ AxP)}=21.6, p<.05$ and $\chi^2_{12\ (PxC,\ AxC)}=39.0$), whereas the third model, depicting two first-order interaction effects (between the pattern of change on analytical items and practical items, and on analytical items and creative items) showed adequate fit ($\chi^2_{12\ (AxC,\ AxP)}=9.6, p=.65$). Fitting the model depicting all first-order interaction effects did not result in a significant incremental chi-square ($\chi^2_{8\ (AxC,\ AxP,\ PxC)}=6.6, p=.57$; incremental $\chi^2_4=3.0$, ns) suggesting that the observed pattern of change is best explained by the model with two first-order interactions. In sum, the pattern of change on analytical tasks appeared to be associated with the pattern of change on both practical and creative tasks; the patterns of change on practical and creative tasks appeared to be independent of each other.

The analyses of the two contingency tables (changes on memory-analytical performance versus changes on practical performance and changes on memory-analytical performance versus changes on creative performance) revealed the sources of the asymmetry. Specifically, in the analytical-by-practical table, there were two under-populated (analytical decliners vs. practical gainers and analytical gainers vs. creative decliners) and two over-populated (analytical decliners vs. practical decliners and analytical gainers vs. practical gainers) cells (for the table, Kendall's τ=.37, p<.001). In the analytical-by-creative table, there was one under-populated cell (analytical decliners vs. creative gainers) and one over-populated cell (analytical decliners vs. creative decliners) cell (for the table, Kendall's τ=.25, p<.001).

In sum, there is a strong association between the change in performance on memory-analytical task and the change in performance on at least one other type of task (either practical or creative). Yet, the changes in performance on practical and creative tasks appear to be independent.

Affective Indicators

To evaluate the affective aspect of the program, we asked teachers and students from the triarchic group to provide an affective view of the program.

Teachers

On a 7-point scale where 1 was low and 7 was high, teachers rated the interestingness of the program to them at 6.0 and the interestingness of the program to the students at 5.0. They rated the level at which it motivated them at 5.4 and the level at which it motivated their students at 5.0. In addition, the teachers thought that the triarchic teaching strategies addressed the needs of students with various levels of skills (4.8) and that the program was inclusive of a wide range of children (5.2).

Students

Students were also asked how they liked the program. Only 36% of the students liked (liked or liked very much) the program, whereas 40% did not care one way or the other. The remaining 24% disliked the program. When the teachers were asked what their students told them about their perception of the program, the feedback was more positive, notably in regards to the practical activities. Thus, about 50% more liked than disliked the program.

General Discussion

Students in three studies who received triarchic instruction generally showed greater gains in reading and comprehension skills within subject matter than did students who received conventional memory-based instruction. Greater gains were shown for a variety of kinds of assessments. The three studies reported here thus suggest that students benefit from triarchic instruction, not only if it is matched to their pattern of

strengths, as in our past research (Sternberg et al., 1996; Sternberg et al., 1999), but also, as in the present research, if it is given in equal fashion to all students (see also Sternberg et al., 1998a). The present work shows that students also benefited without regard to the grade level or subject matter tested.

Of course, we make no claim that triarchically based instruction uniquely will improve reading, vocabulary, or other achievement. Instruction based on other theories of intelligence (e.g., Gardner, 1993) might also result in enhanced achievement. Moreover, the three studies here represent tests of the theory at only certain age levels, for certain subject-matter areas, and in a limited number of settings. In combination with previous studies, and as a package, however, the indications are that triarchic instruction can have a positive effect upon student achievement. Of course, there may be as yet undiscovered circumstances where it is not effective.

Our program was a program for teachers. We trained all teachers how to better teach reading and, in addition, we taught teachers from the experimental group how to teach reading triarchically. We delivered the triarchic methodology to teachers, we supplemented their teaching with extensive materials, and we made them a part of the research by channeling the program to their students exclusively through them and encouraging them to use research to further changes in their students' performance (Feldman, 1994, 1999; Rearick & Feldman, 1999). The qualitative observational data we collected suggest that the impact of the triarchic training resulted in (a) the presence of long-lasting changes in teachers' behaviors, (b) greater awareness of their own teaching repertoire, shown by teachers in the triarchic group, and (c) greater commitment to seeing a change in their students' performance in the triarchic-group compared to the control group teachers. Yet, we need to explore and quantify the impact of triarchic training in greater detail.

Quasi-experimental studies done in actual classroom settings (Studies 1 and 3) often have certain design limitations, and it behooves us to mention some of these possible limitations here as they apply to our own work.

First, in Studies 1 and 3, we used intact classes in which neither assignment of pupils nor of teachers to classes was random. Ideally, of course, these assignments would be random. In order to compensate for nonrandom assignment of pupils to classes (and hence to conditions), we used achievement-test scores as well as other possible confounding variables as covariates. In fact, we did sometimes find prior differences. But obviously, experimental control is superior to statistical control for prior group differences.

Second, one might argue, that "the traditional instruction sounds deadly," and thus might have produced weaker gains because it encouraged students "to tune out." But this argument is not an indictment of our study, but of the existing educational system in which children are educated. Students in the traditional instruction group received an enhanced version of the regular instruction they would have received if we had not intervened. Their instruction was of the kind that millions of students in the U.S. and

elsewhere receive every day. If anything, the memory-based enhancements may have made it better than typical instruction.

Third, one could argue that the results were due to some kind of Hawthorne effect, whereby teachers or students in better-performing groups were more motivated to do well or to please the researchers than were students and teachers in the weaker-performing groups. This explanation is implausible, however. All teachers received an intervention that was designed to improve their teaching competencies. There is no a priori or a posteriori reason to believe that our interventions with different groups of teachers were differentially motivating.

Fourth, how do we know that the analytical, creative, and practical modes of thinking, as represented by the three types of activities and assessments, respectively represent different types of thinking in any meaningful sense? Perhaps, for example, they just represent trivially different elaborations of the same kinds of thinking. To address this question, we have conducted construct-validation studies that attempt to assess whether the three modes of thinking are really different. We present problems of the three kinds to students and ask them to solve these problems. We then use exploratory and/or confirmatory factor analysis in order to determine whether, structurally, the three kinds of items are distinct or not (e.g., Sternberg et al., 1999; Sternberg, Castejón, Prieto, Hautamäki, & Grigorenko, 2001). Our results suggest that the three kinds of thinking truly are distinct, rather than being minor variants of each other (see also Sternberg & Lubart, 1995; Sternberg et al., 2000). Thus, our data suggest that triarchic instruction results not just in "more" thinking, but "more diverse kinds" of thinking.

Finally, it may be, as also has been suggested in the past, that the advantage of triarchic instruction is that it is more "exciting." If that is the reason or part of the reason for the greater gain in the triarchic condition, we accept the reason with pleasure. We are all in favor of producing teaching that stimulates and excites students and thereby leads to improved performance. We cannot and would not rule out greater excitement as one possible source of our effects, although the generality of the gains across ages, subject matter, and dependent measures suggests that perhaps other factors were operating as well.

We believe that there is an urgent need for teaching to all abilities, and then assessment of achievement based on such broad teaching. The time has come to stop wasting human resources because students' talents happen not to correspond to the skills that schools traditionally have emphasized. Creative and practical abilities are at least as important in life as are memory and analytical abilities, and they can be as important in school if a school chooses to emphasize these abilities. Ultimately, we believe such emphasis will benefit individual students, schools, and society as well.

Intervention Study III—Improving Reading Instruction: The Triarchic Model

Robert J. Sternberg, Elena L. Grigorenko, & Linda Jarvin

Children can read much better than they do now. One of the reasons they do not read better is that the field of reading has gotten locked into a senseless battle that has generated a great deal of heat, little light, and less improvement in the reading skills of children with these children being caught up as pawns in the battle.

The battle is between advocates of the phonics method and advocates of the whole-language method. The former method emphasizes children acquiring reading skills by learning sound-letter correspondences for various language patterns. The latter method emphasizes children acquiring reading skills by reading whole texts in their natural context. The contrast between the two methods is a false dichotomy.

Today, many scholars recognize that good reading instruction integrates aspects of the phonics method with aspects of the whole-language method (Pressley, 1998). This synthesis represents a major step forward from simplistic notions that one system or another must be right. But it does not fully recognize that reading comprises a complex set of cognitive skills that, like other cognitive skills, best can be understood and taught and then assessed in the context of an integrated model of human cognition.

The Triarchic Model of Human Cognition

We have proposed such a model, which we refer to as a "triarchic" theory of human cognition (Sternberg, 1997a, 1997b, 1999b). It is called triarchic because it has three parts, corresponding respectively to analytical, creative, and practical cognitive skills. This theory can be applied to teaching any subject matter at any grade level (see Sternberg & Grigorenko, 2000; Sternberg & Spear-Swerling, 1996).

Students think analytically when they analyze, judge, evaluate, compare and contrast, and critique. They think creatively when they create, invent, discover, imagine, and suppose. They think practically when they implement, use, apply, and put into practice what they have learned. This kind of teaching does not conflict with teaching for memory. One cannot analyze what one knows (analytical thinking), go beyond what one knows (creative thinking), or apply what one knows (practical thinking) if one does not know anything!

Some Past Findings Based on the Triarchic Model

In previous research (Sternberg, Ferrari, Clinkenbeard, & Grigorenko, 1996; Sternberg, Grigorenko, Ferrari, & Clinkenbeard, 1999; Sternberg, Torff, & Grigorenko,

1998a, 1998b), we have shown that children who are taught triarchically are at an advantage over children taught in a variety of other ways. For example, we have found that high school students who are taught at least part of the time in a way that matches their analytical, creative, and practical pattern of ability outperform students who are taught in a way that does not match their pattern of strengths. We also have found that middle and high school students who are taught social studies or science triarchically learn the material better than do students who are taught either just for critical thinking (analytical) or primarily for memory. They excel in their performance not only on performance tests measuring analytical, creative, and practical achievement, but even on multiple-choice tests that emphasize little more than their memory for the material they have learned. What is most important is that students who formerly were not achieving at high levels start achieving at high levels when they are taught triarchically.

What Triarchic Teaching Means and Why It Succeeds

Triarchic teaching means teaching not only to students' strengths, but also, to their weaknesses (Sternberg, 1999b). Students need both to capitalize on their strengths and to compensate for or correct their weaknesses. Moreover, triarchic teaching involves having students think of learning so that they learn to think. Teaching activities ultimately need to develop the three kinds of thinking skills not only in isolation, but rather, in the kind of integrated fashion that they typically use in everyday problem solving.

Why does triarchic teaching succeed? We believe there are four fundamental reasons. First, triarchic instruction involves teaching students to encode material not just in one way, but in three different ways so that the students are better able to retrieve and ultimately to use the material. Quite simply, if students have more mental retrieval routes to access the material they have learned, the more likely they are able to access and *use* the material. Second, triarchic instruction enables students to capitalize on their strengths and to compensate for or correct their weaknesses. In other words, the students optimize the use of their pattern of abilities, whatever that pattern is. Because all students are taught in all three ways at least some of the time, it is not necessary to individualize instruction to each individual separately. Third, triarchic instruction motivates students more than does conventional instruction because the material, when it is taught triarchically, simply is more interesting than it is when the material is taught conventionally. Fourth, triarchic instruction motivates teachers more than does conventional instruction. It simply is more enjoyable and rewarding for the teacher.

Most teachers find that triarchic instruction is not all so different from their past instructional experience. Rather it is quite compatible. The triarchic model simply encourages teachers to balance analytical, creative, and practical, as well as memory-based activities, rather than to concentrate on any one of these kinds of activities. It provides a way of enabling them to do better what they already know how to do, but, for a variety of reasons, may not get around to doing.

The Triarchic Model Applied to the Teaching of Reading

The studies described here represent our first attempt at applying the triarchic model specifically to reading at the middle to high school levels. Our hypothesis was that reading performance should be improved by applying a general theory of human cognition to the reading process. After all, reading is part and parcel of, and really in no way cleanly separable from, the rest of cognition. Poor readers generally show a variety of problems in their cognitive processing of reading material (Spear-Swerling & Sternberg, 1996; Sternberg & Grigorenko, 1999).

We did not go into schools with a new reading program expecting these schools to buy into it because most schools already have a reading program in which they have invested substantial resources, including time, effort, and money. Although some schools are willing to consider a completely new reading program, more schools are interested in making whatever reading program they already have in place work better. Our goal was their goal: to show teachers how to use an existing program of instruction—in reading and in other subject areas—more effectively so as to attain better student achievement in reading.

Over 1,200 students from the middle school to the high school level were involved in the three studies briefly described here. The district in which we worked was generally lower to lower-middle socioeconomic class and, on average, had statewide reading test scores at or near the bottom of the state. Students were extremely diverse racially and ethnically, with the large majority of them being African American or Hispanic. All studies were done with both an experimental group (which received our triarchically-enhanced program of reading instruction) and a control group (which, in two of the three studies, received the normal program of reading instruction enhanced to improve students' memory for what they learned; in the other study, there was no special intervention for the control group). All students received a pretest as well as a posttest to measure their proficiency in vocabulary and reading comprehension skills. Teachers in both the experimental and (for two studies) the control groups received in-service workshops, but on different material. The teachers in the experimental group were taught over 2 days on how to use triarchic methods with the material they already were using to teach reading. In two out of three studies, the teachers in the control group were taught how to use mnemonic (memory-based) techniques to improve reading. In the third study, conducted as a summer program, there were no special control group teachers. Experimental group children took the summer program during the summer of 1998, whereas control group children took it the following summer (1999). Both groups, however, took a pretest and a posttest in the summer of 1998.

The instructional interventions were different in the different studies. The nature of the intervention depended on the particular circumstances. In the first study, with middle school (grade 5) students, we worked with the existing reading program, *Light Up the Sky,* a reading basal program published by Harcourt (Farr & Strickland, 1993). In the second study, conducted in three public high schools in urban districts, we taught reading in the context of existing classes in mathematics, physical sciences, social sciences,

English, history, foreign languages, and the arts. In the third study, we taught middle school students in a summer program via two novels, *A Raisin in the Sun* by L. Hansberry and *The Lottery Rose* by I. Hunt. Examples below are from the first study, although we do have many illustrations from all three studies. (The complete set of materials can be found on our website: www.yale.edu/triarchic .)

Consider in more detail the program using *Light Up the Sky*. The study was divided into three phases. In Phase 1, two stories ("The Speech" and "Teacher for the Day") served as pretest units. In Phase 2, two stories ("New Home in Ohio" and "The Great Caravan on the National Road") were used as intervention units. In Phase 3, another two stories ("Like Jake and Me" and "Many Moons") served as intervention units and then as bases for the final posttest. For all six stories, the following materials were developed: (a) homework assignments (from which students were given a choice of one assignment from a list, including analytical, creative, and practical assignments); (b) vocabulary assessments (18 items: 6 analytical, 6 creative, 6 practical); (c) reading comprehension assessments (18 items: 6 analytical, 6 creative, 6 practical). Teachers' guides were developed for the four intervention units based on the triarchic instruction and assessment paradigm. These guides showed teachers how to teach traditional language-arts skills (vocabulary, reading comprehension, spelling, writing) so as to develop students' analytical, creative, and practical skills and achievement.

Examples of Materials

Instructional Activities

The following examples were chosen from the materials developed to accompany "A Great Caravan on the National Road," a story set at Christmas-time in 1890. It tells the story of the Bell children waiting for their relatives, who are traveling down the National Road. The National Road is both a part of American history, as it was the way west for pioneers, and of the Bells' family history, because that is where Papa lost his leg in an accident. After setting up the context for the story on Day 1, the teacher focused on vocabulary and spelling during Days 2 to 4, combining analytical, practical, and creative activities to enhance vocabulary acquisition. Day 5 was focused on reading the story. Day 6 was devoted to analytical activities, using graphic aids for analyzing characters, relationships, and events. Creative activities and the use of descriptive language were the focus of Day 7. Finally, practical activities related to planning family gatherings were explored on Day 8, and the students were encouraged to connect the story to their personal lives on Day 9.

Below are examples of analytical, creative, and practical activities in which the students were engaged.

Analytical

An example of an analytical activity was the use of graphic aids for analyzing a piece of writing and organizing information. A first example was the use of a family tree to discuss relations among characters in the story. Students were asked to list the characters that appeared in the story, and the teacher brought up the notion of a family tree. Once all the characters in the story had been listed and organized into a family tree, students were encouraged to think about the relationships between characters, that is, the way characters felt about and interacted with each other, rather than their blood relations. Throughout this activity, the teachers elicited student response by guided questioning and by directing students back to the appropriate passages in the text. A second example of a graphic aid was a time line that students drew to organize events in the order in which they transpired. Students were encouraged to recall all the events described in the story, and then to organize them in the form of a diagram, showing the passage of time from the past to the present.

Creative

An example of a creative activity for the story "A Great Caravan on the National Road" was a focus on descriptive language. To get the ball rolling, the teacher elicited a classroom discussion about the use of descriptive language to create an atmosphere for a story and different techniques were discussed. Then, the students were encouraged to find examples of the author's appeal to human senses (what is seen, heard, smelled, tasted), and the use of both onomatopoeias and of hyperboles in the text. For the main activity, students were then divided into small groups, and each group was assigned a particular setting to describe. Some of the suggested settings included "A park on a spring afternoon," "A busy pizza restaurant," and "A zoo." Students were asked to use descriptive language creatively to help their classmates really feel like they were present in the particular setting and were given a handout with writing prompts such as "Describe what you see;" "Describe what you hear (Write at least one onomatopoeia. For example, if you were in a pet store, you might be surrounded by woofs and tweets!);" or "Describe what you smell (Write at least one exaggeration. For example, if you were in a gym, the air might smell like a million sweaty socks!)."

Practical

An example of a practical activity was a group brainstorming session to plan a family gathering. "A Great Caravan on the National Road" tells the story of the Bell family's Christmas celebration, and students were asked to work as a group to think about the practical aspects behind the organization of a family gathering that brings together several generations. On a handout, students listed the kinds of foods and drinks they would prepare, the kinds of activities that the family members could take part in on that special day, and the kinds of gifts that they might give each other. This group activity was followed by the entire class taking part in a problem-solving discussion. Students were asked to solve everyday situations in which things go wrong; for example, "Suppose that your Aunt and Uncle were cooking the holiday meal in the kitchen and burned the

main course. What would be the best thing to do?" or "Suppose that one of the children threw a noisy, disruptive temper tantrum, right when everybody was sitting down to dinner. What would be the best thing for the family to do?"

Assessments

Three kinds of assessments were also developed for each story: The comprehension and vocabulary assessments evaluated analytical, creative, and practical achievements with a mix of multiple-choice and open-ended questions, whereas for the homework question, students were offered a choice of one of three essay topics, which focused on analytical, creative, or practical achievements.

Below are examples for the story "A Great Caravan on the National Road."

Comprehension/Analytical

Explain what Jason means when he says to Papa and Uncle Levi, "What true brothers you are!"

Comprehension/Creative

The local paper is printing an article about the Bell family's hundred-year history on the National Road. Think of what a good, catchy headline for the article would be.

Comprehension/Practical

Alec's family is having a reunion. Alec's cousin, Dale, is there. Dale lives farther away than the other relatives and does not know anyone well. He is standing shyly in the corner. What should Alec do to make things more comfortable?

Alec should ask his Aunt Clara why Dale is so quiet.
Alec should gently suggest a game the two boys could play together.
Alec should tell Dale he is weird.
Alec should ignore Dale.

Vocabulary/Analytical

Theodore was _____ ! His father had just surprised him with a new bicycle, and Theodore was so happy and stunned that he did not know what to say.

Analyze the paragraph and circle the best choice to fill in the blank above:

angry
nearsighted
speechless
dynamic

Vocabulary/Creative

Think of and write an interesting sentence with the word "applauded" in it.

Vocabulary/Practical

Ingrid's parents were upstairs finishing getting dressed when Reverend Walker, the Minister, arrived for dinner. Ingrid should

ask the minister to leave and come back later.
ask the minister to wait on the porch until her Mom and Dad are ready.
show the minister into the parlor.
show the minister into the laundry room.

Homework

Write or record your response to one of the following.

Suppose you have just spent a special holiday with your relatives and friends. Your favorite cousin could not be there because he is in the army and is stationed far away. Write your cousin a letter fully describing the big day so that he will feel almost as if he had been there. *(Creative)*

In the story, the Bells have a large family gathering, full of food and different activities. It takes a lot of planning to put on such a big party. Pretend you are Jason's parents, and you are hosting the event. Describe some things you would do to prepare. (*Practical*)

The story is, in part, about the Bells' family history—the "good times" and "bad times" they have experienced living for generations along the National Road. Identify at least one "good time" and one "bad time" referred to in the story. As fully as you can, describe these events and explain their importance to the Bell family. *(Analytical)*

By using the activities and assessments described above, teachers in the triarchic condition combined several approaches and addressed student abilities in three areas (analytical, creative, and practical), as compared to "traditional" teachers, who would focus on the memory and analytically based activities offered in the textbook. Below are examples of questions suggested by the book:

What are some of the things that made the Christmas of 1890 so memorable for Jason?
What is Uncle Levi's Christmas present to Papa?
What Did We Find?

Consider the data for the fifth graders. (The other data were comparable.) Altogether, 809 fifth graders participated in the study. However, only 708 students were

present in school for the administration of the full set of eight assessments (four for the pretest and four for the posttest). Statistical analysis showed that there were no demographic differences between those students who completed all the assessments and those who missed some of the assessments. Here we present the data only for the 708 students who completed all assessments.

Of the 708 students, 298 were boys (42%), 313 were girls (44%), and district files did not provide gender information for the other 97 students (14%). The ethnic composition was 309 (44%) African American, 155 (22%) Hispanic American, 53 (7%) European American, 83 (12%) from other ethnic minorities, and 108 (15%) with no ethnic data or multiple ethnic data registered. There were 450 students in the experimental (triarchic instruction) group and 258 students in the control (regular instruction) group.

Cognitive Data

Each child was assessed 8 times—4 times at the pretest (with two vocabulary assessments and two reading comprehension assessments) and 4 times at the posttest (again with two vocabulary and two reading comprehension assessments). Altogether, there were 24 analytical, 24 creative, and 24 practical items administered at both the pretest and the posttest. The results of the pretest-posttest comparisons for the two groups (experimental and control) are shown in Figure 3.1.

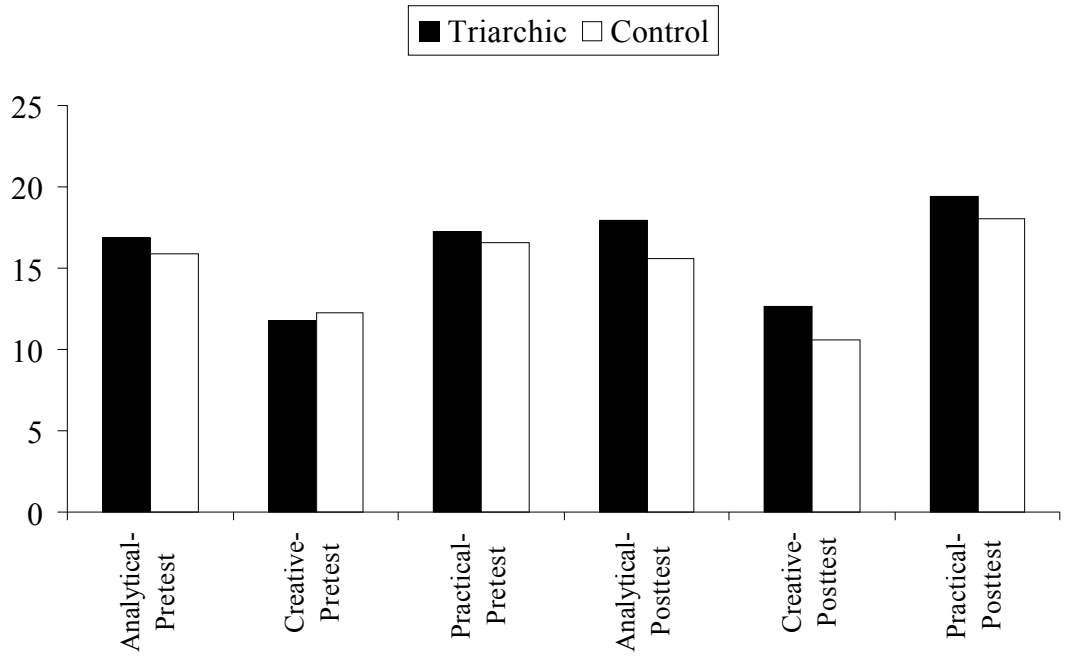


Figure 3.1. Comparison of triarchic and control participants for pretest and posttest. Analytical, creative, and practical scores are shown separately.

Differences were labeled as significant if the probability of obtaining the data we did get were no different between groups at a rate of less than 1%. At the pretest, there were no significant differences between groups, with the exception of the analytical scores being higher in the triarchic than in the regular-instruction group (16.88 versus 15.90). At the posttest, however, students in the triarchic group significantly outperformed students in the control group on all three types of tasks: analytical (17.97 versus 15.58), creative (12.70 versus 10.60), and practical (19.44 versus 18.00). Moreover, pretest to posttest gains for all three kinds of tasks were significantly greater for the triarchic than for the regular-instruction group.

Affective Data

We asked teachers and students from the triarchic group to provide an affective view of the program.

Teachers

On a 7-point scale where 1 was low and 7 was high, teachers rated how interesting the program was to them at 6.3 and how interesting it was to their students at 5.6. They rated the level at which it motivated them at 6.1 and the level at which it motivated their students at 5.7. In addition, the teachers thought that the triarchic teaching strategies addressed the needs of students with various levels of skills (6.0) and that the program was inclusive of a wide range of children were (5.9).

Students

Students were also asked how they liked the program. We found that 36.4% of the children indicated they liked the program very much; 44.4% liked it; 12.1% did not feel one way or another; and only 7.1% disliked it.

Observational Data

In a videotaped sequence from one of the fifth grade classrooms participating in our program, an experienced New Haven teacher explains how one of her student's achievement improved with the new program. The girl raised her spelling scores from F (under 60) to an 82 after she learned spelling through multiple activities, including looking at the word, breaking it apart, visualizing it, saying it aloud in her own voice, and saying it and then spelling it in syllables before actually writing the word.

Another illustration of the program's effectiveness is further shown on the video. A student uses the vocabulary word *relic* (which was taught two lessons prior) to answer the question: "How can you keep your family's history alive?" For this teacher, it was the emphasis on addressing all the components of learning that made a difference between the triarchic program and traditional ways of teaching, and, in her own words, "gives everyone a chance to shine."

To the extent that one's goal is to improve children's reading skills as well as other skills, the triarchic model provides a successful basis for instruction and assessment. Children can achieve more if they are taught in a way that makes sense in terms of theory, in terms of practice, and in terms of the needs of students and teachers.

We are currently applying our model to teaching fourth grade reading, mathematics, and science in a large scale national study. Our goal, once again, is to examine the efficacy of triarchically based instruction versus critical thinking based instruction and conventional instruction. Through studies such as this one, we hope to show that we can "scale-up" our interventions so that they can work in any school, in any subject matter, and at any grade level.

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Endnotes

[1] All demographic information (age, gender, and ethnicity) was obtained through the school district files. The missing data points correspond to those missing in the district master files.

[2] See endnote 1.

[3] A condition of this U.S. Department of Education award was to carry out the research in a so-called enterprise zone, such as New Haven, CT. During Year 2 of the study we worked with all but one of the middle schools in New Haven.

[4] After the first implementation year, some changes were made in the curriculum. Specifically, spelling lessons were added to the program, and a number of modifications were made to assessment materials.

[5] All instructional and assessment materials are available at www.yale.edu/pace/resources, under the heading "Educational Resources."

[6] Examples of the rubrics are available at www.yale.edu/pace/resources, under the heading "Educational Resources."

[7] In general, the results of the analyses of the general quality indicators replicated the results for specific abilities (in all three studies), meaning that the experimental groups improved more than the control groups. Due to the large volume of information in this monograph, these data are not presented here, but are available upon request.

[8] Specifically, the results were as follows. When vocabulary and comprehension indicators were compared across the four stories for memory-analytical, creative, and practical creative assessments, the amount of variance accounted for by first principal components ranged from 61 to 73% (median=69%). When assessment indicators were compared across stories within the pretest and posttest, the amount of variance accounted for by first principal components ranged from 62 to 78% (median=69%).

[9] Thus, there were 6 pretest indicators (analytical, creative, and practical abilities evaluated separately through vocabulary and comprehension assessments) and 6 posttest indicators (the structure of which was identical to that of the pretest). The following a-coefficients were obtained for different subtests: (1) pretest: (a) vocabulary—a=.81(Year 1)/.71(Year 2) for analytical, a=.83(Year 1)/.83(Year 2) for creative, and a=.83(Year 1)/.71(Year 2) for practical; (b) comprehension—a=.85(Year 1)/.74(Year 2) for analytical, a=.85(Year 1)/.79(Year 2) for creative, and a=.81(Year 1)/.72(Year 2) for practical; and (2) posttest: (a) vocabulary—a=.91(Year 1)/.75(Year 2) for analytical, a=.80(Year 1)/.68(Year 2) for creative, and a=.91(Year 1)/.68(Year 2) for practical; (b) comprehension—a=.84(Year 1)/.63(Year 2) for analytical, a=.76(Year 1)/.61 (Year 2) for creative, and a=.85(Year 1)/.55(Year 2) for practical.

[10] In all three studies, when possible, individual missing values were imputed.

[11] To verify the robust nature of the obtained results, we utilized two other methods for detecting and quantifying change. First, we carried out a MANCOVA, in which the dependent variables were the posttest scores for memory-analytical, creative, and practical performance and the model included the pretest indicators, the CMT indicators, and the fixed factors of group, ethnicity, and gender. The resulting models were statistically significant for all three dependent indicators, detecting a variety of substantial effects (x^2=.383, x^2=.359, and x^2=.361 for memory-analytical, practical, and creative models, respectively). Most importantly, there was a significant multivariate effect of *Group* ($F_{3,548}$=3.2, p<.05, x^2=.017); the corresponding univariate tests indicated that the group differences were statistically significant for practical ($F_{1,550}$=5.6, p<.05, x^2=.010) and creative ($F_{1,550}$=6.9, p<.01, x^2=.012), but not memory-analytical indicators. Second, we conducted a set of analyses of variance comparing gain scores in both groups. The multivariate test revealed a significant main effect of *Group* ($F_{3,699}$=6.0, p<.001, x^2=.025). The pattern of the results for the subsequent univariate analyses was similar to that reported before—the gains were significantly higher in the triarchic group for practical ($F_{1,701}$=13.6, p<.001) and creative ($F_{1,701}$=8.2, p<.01), but not memory-analytical indicators.

[12] All instructional and assessment materials are available at www.yale.edu/pace/resources under the heading "Educational Resources."

[13] The students were allowed to look back at the passage while answering questions.

[14] *A Raisin in the Sun* is the story of the Youngers, an African-American family living in a Chicago ghetto in the 1950s. Lena Younger is the recently widowed matriarch of the family. Lena shares a crowded apartment with her two children, Walter and Beneatha, daughter-in-law Ruth, and grandson Travis. When the late Mr. Younger's life-insurance check arrives in the mail, a conflict arises among the family members as to how the money should be spent. Lena takes one-third of the money and buys a house in Clybourne Park, a predominantly White neighborhood. She gives Walter the rest of the money to be divided equally between him and Beneatha. Walter's dream of quitting his job as a chauffeur and running his own business collapses when his business partner skips town with the insurance money. To make matters worse, Walter had given his "friend" Beneatha's share as well—the money she had planned to use for her medical school tuition. In the midst of this turmoil, Mr. Lindner arrives at the Youngers' apartment on behalf of the Clybourne Park Improvement Association. He offers to pay the family more than the house is worth in order to keep "colored folk" out of the neighborhood. This intimidation and antagonism at a time when the family is experiencing dire financial straits threatens to crush the family, and they are tempted to sell their dream house. But at the last minute Walter takes command in a display of pride and understanding, and tells Mr. Lindner that they refuse to sell. The Youngers are left with the house and, more importantly, a renewed sense of dignity.

[15] Georgie Burgess is severely abused by his mother and her boyfriend, Steve. Even his teacher, Miss Cressman, thinks he is stupid and treats him accordingly. Georgie learns to cope by withdrawing into a safe and secret world of beautiful gardens filled with roses, just like those in the library books he treasures. One day, Georgie wins a small rosebush in a lottery held at the grocery store where the kind Mrs. Sims works. After a particularly brutal beating from Steve, Georgie goes to live with Mr. and Mrs. Sims, a childless family in the neighborhood who takes a liking to the boy. But, since the couple cannot afford to adopt the child, Georgie is sent to a home for boys run by Sister Mary Angela. In her wisdom, Sister Mary Angela assigns her "public relations boy", Timothy, to be Georgie's guide around school. The two become close friends. While at the new school, Georgie finds the perfect place to plant his "lottery rose"—across the street from the school in Mrs. Harper's garden. Mr. Collier, Mrs. Harper's father, explains that his daughter may not like the new rosebush because the garden became her sacred sanctuary after the car accident that killed her husband and young son. Sure enough, when Mrs. Harper sees Georgie's rosebush in her private garden she reacts with anger, uprooting the precious bush from the garden and losing Georgie's trust. Through his close relationships with Sister Mary Angela, Timothy and Mr. Collier, Georgie learns to trust people and to believe in himself. Eventually, he is able to forgive Mrs. Harper for her initial anger, and their relationship provides each of them with much-needed love and mutual understanding.

[16] Examples of the rubrics are available at www.yale.edu/pace/resources, under the heading "Educational Resources."

[17] To verify the robustness of the obtained results, we utilized two other methods for detecting and quantifying change. First, we carried out a MANCOVA, in which the dependent variables were the posttest scores for memory-analytical, practical, and creative performance and the model included the pretest indicators as covariates and the fixed factors of group. The resulting models were statistically significant for all three dependent indicators, detecting a variety of substantial effects (x^2=.451, x^2=.558, and x^2=.629 for memory-analytical, practical, and creative models, respectively). Most importantly, there was a significant multivariate effect of *Group* ($F_{3,54}$=8.5, p<.001, x^2=.320); the corresponding univariate tests indicated that the group differences were statistically significant for practical ($F_{1,56}$=12.3, p<.001, x^2=.180) and creative ($F_{1,56}$=20.2, p<.001, x^2=.265), but not memory-analytical indicators (p<.1). Second, we conducted a set of analyses of variance comparing gain scores in both groups. The multivariate test revealed a significant main effect of *Group* ($F_{3,57}$=4.7, p<01, x^2=.198). The univariate results were as follows—the gains were significantly higher in the triarchic group for creative assignments ($F_{1,60}$=12.0, p<.001), borderline significantly higher for practical assignments ($F_{1,60}$=3.4, p<.07), and did not differ in the two groups for memory-analytical assignments.

[18] Examples of the rubrics are available at www.yale.edu/pace/resources, under the heading "Educational Resources."

[19] Eight of the 99 students in the experimental group happened to be enrolled in different classes taught by the experimental group teachers. In addition, three students from the control group accidentally took the pretest twice. Consequently, on either the pre or posttest, we obtained two records for each of these

students. One of these records was dropped at random; the other was preserved for the analyses.

[20] To verify the robust nature of the obtained results, we utilized two other methods for detecting and quantifying change. First, we carried out a MANCOVA, in which the dependent variables were the posttest scores for memory-analytical, practical, and creative performance and the model included the pretest indicators as covariates and the fixed factors of group. The resulting models were statistically significant for all three dependent indicators, detecting a variety of effects (x^2=.175, x^2=.124, and x^2=.097 for memory-analytical, practical, and creative models, respectively). Most importantly, there was a significant multivariate effect of *Group* ($F_{3,189}$=3.2, p<.05, x^2=.048); the corresponding univariate tests indicated that the group differences were statistically significant for memory-analytical ($F_{1,191}$=8.8, p<.01, x^2=.044) and practical ($F_{1,191}$=6.4, p<.01, x^2=033), but not creative indicators. Second, we conducted a MANOVA comparing gain scores in both groups. The multivariate test revealed a significant main effect of *Group* ($F_{3,194}$=7.5, p<.001, x^2=.104). The univariate results were as follows—the gains were significantly higher in the triarchic group for practical assignments ($F_{1,196}$=21.9, p<.001), borderline significantly higher for memory-analytical assignments ($F_{1,196}$=2.4, p<.1), and did not differ in the two groups for creative assignments.

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The National Research Center on the Gifted and Talented Research Teams

University of Connecticut

Dr. Joseph S. Renzulli, Director
Dr. E. Jean Gubbins, Associate Director
Dr. Sally M. Reis, Associate Director
University of Connecticut
2131 Hillside Road Unit 3007
Storrs, CT 06269-3007
860-486-4676

Dr. Del Siegle

University of Virginia

Dr. Carolyn M. Callahan, Associate Director
Curry School of Education
University of Virginia
P.O. Box 400277
Charlottesville, VA 22904-4277
804-982-2849

Dr. Mary Landrum
Dr. Tonya Moon
Dr. Carol A. Tomlinson
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Yale University

Dr. Robert J. Sternberg, Associate Director
Yale University
Center for the Psychology of Abilities, Competencies, and Expertise
340 Edwards Street, P.O. Box 208358
New Haven, CT 06520-8358

Dr. Elena L. Grigorenko