

Styles of Learning and Thinking

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Styles of Learning and Thinking Matter in Instruction and Assessment

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ABSTRACT—There are two styles of learning and thinking: ability based and personality based. The former are assessed by maximum-performance tests, and the latter are assessed by typical-performance tests. We argue that both kinds of styles matter for instruction and assessment in school. In particular, shaping lessons based on an awareness that people learn and think in different ways can lead to improved instructional outcomes. We describe one ability-based theory and one personality-based theory and present supporting data from multiple studies relevant to each.

People learn and think in different ways. That statement at first seems obvious. For example, two students whose knowledge and understanding of the material learned in school are identical may nevertheless manifest their achievements differently. One may do better on a multiple-choice test measuring memory of facts, the other may do better on an essay test that encourages creative use of the material that has been learned. This may be a result of skill-based differences between the two students taking the two different kinds of tests, preference-based differences for the two kinds of tests, or both.

The thesis of this article is that there are both ability-based and personality-based styles that matter for instruction and assessment. Taking these styles into account can improve instruction and assessment. Not taking them into account prevents students from capitalizing on strengths and/or compensating for or correcting weaknesses and thus is suboptimal.

In this article, we discuss styles as a basis for understanding individual differences in how people learn and think. First we define what styles are. Then we describe how styles apply to two theories (Sternberg, 1997a, 1997b) and draw our conclusions.

DEFINING STYLES

We define styles here as individual differences in approaches to tasks that can make a difference in the way in which and, potentially, in the efficacy with which a person perceives, learns, or thinks. We limit our definition of styles to those that matter for cognition because, in our view, that was the original intention of the “cognitive styles movement”—identifying styles of processing information that are consequential for cognition (e.g., Gregorc, 1979, 1985; Kagan, Rosman, Day, Albert, & Philips, 1964;

Kirton, 1976; Kogan, 1973; Marton, 1976; Marton & Booth, 1997; Witkin, Dyk, Faterson, Goodenough, & Karp, 1962).

The styles literature focuses on two specific aspects, sometimes referred to as “ability-based” and “personality-based” theories of styles (Sternberg, 1997b; Zhang & Sternberg, 2005, 2006).¹ Styles also may be measured by either ability-based or personality-based measures, much as emotional intelligence is measured in both ways (see Mayer, Salovey, & Caruso, 2000). As in the case of emotional intelligence, the styles measured by ability-based and personality-based assessments are not the same constructs. We label the former as *ability-based styles* and the latter as *personality-based styles*, although these terms do not totally capture the difference between them. Styles traditionally have been viewed as the interface between cognition and personality (Sternberg, 1997b), and it probably stands to reason that their formulation and measurement has drawn on both the cognitive and personality literatures.

According to our definition, abilities and attributes measured by maximum-performance tests or by typical-performance tests are styles only if they interact with performance-based outcomes of learning or thinking. In this view, the extent that a given ability- or personality-based attribute affects differences in a student’s learning or thinking performance outcomes establishes it as a style. Thus, the concepts that constitute styles are inherently interactive. Thus, abilities or personality attributes that do not interact with instruction or assessment would not be considered styles for the purposes of this article.

Consider, for example, verbal and spatial skills. To the extent that a factor analysis or some other technique shows them to be psychologically separable, they may

be referred to as distinct abilities (e.g., Thurstone, 1938). To the extent that they result in individual differences in how students approach and then solve or learn to solve linear syllogisms such as “Tom is taller than Mary. Beth is shorter than Mary. Who is tallest?,” they are ability-based styles (e.g., Sternberg & Weil, 1980). People may approach the task in different ways, with results depending on their patterns of abilities or personality attributes (MacLeod, Hunt, & Mathews, 1978).

This argument is by no means self-evident. Cronbach and Snow (1977) exhaustively examined the literature on aptitude–treatment interactions and found little except some interactions of instructional outcomes with so-called general intelligence (*g*). We argue that the failure to find interactions three decades ago reflected the state of psychological theory and educational measurement at that time and that modern psychological theories and assessments will allow us to identify different styles and show that they matter in education.

There are many theories of both ability-based styles (see Cianciolo & Sternberg, 2004; Sternberg, 2000, for reviews) and personality-based styles (see Sternberg & Zhang, 2001; Zhang & Sternberg, 2006, for reviews). For example, Gardner (1983) has proposed a well-known theory of multiple intelligences, which posits that people can learn in different ways. He has applied this theory to instruction and assessment (Gardner, 1993). Similarly, Gregorc (1985) has proposed a personality-based theory of styles that has been widely used for educational and business purposes, and Renzulli and Smith (1978) have studied different styles of learning. Our goal here is to draw on just one ability-based theory and one personality-based theory to make the argument that both kinds of styles can matter for educational interventions. We do not claim, however, that these theories

are unique in being able to yield interactions. We believe that any number of other theories might yield similar results. The two theories on which we draw are the theory of successful intelligence (Sternberg, 1997a, 1999, 2005) and the theory of mental self-government (Sternberg, 1988, 1997b).

ABILITY-BASED STYLES: SUCCESSFUL INTELLIGENCE

The Theory of Successful Intelligence

The theory of successful intelligence suggests that students' failures to achieve at a level that matches their potential often results from teaching and assessment that are narrow in conceptualization and rigid in implementation (Sternberg, 1997a; Sternberg & Grigorenko, 2007). The ways in which teachers teach do not always match the ways in which students learn. The traditional methods, in essence, typically shine a spotlight on a small number of students with certain ability-based styles and almost never focus on a large number of potentially successful students with ability-based styles that do not correspond to the patterns of learning and thinking valued by the schools. To rectify this situation, one must value other ability-based styles and change teaching and assessment so that these other ability patterns can lead to success in school.

According to the proposed theory, *successful intelligence* is the use of an integrated set of abilities needed to attain success in life, however an individual defines it, within his or her sociocultural context. People are successfully intelligent by virtue of recognizing their strengths and making the most of them while at the same time recognizing their weaknesses and finding ways to correct or compensate for them. Successfully intelligent people adapt to, shape, and select environments through a

balanced use of their analytical, creative, and practical abilities (Sternberg, 1997a, 1999). Knowledge is also plays a key role, because one cannot think analytically, creatively, or practically if one does not have knowledge stored in long-term memory for application.

People typically balance the three kinds of abilities (analytical, creative, and practical thinking). They need creative thinking to generate ideas, analytical thinking to determine whether they are good ideas, and practical thinking to implement the ideas and to convince others of the value of those ideas. Most people who are successfully intelligent are not equal in these three abilities, but they find ways of using all three together harmoniously and advantageously.

Ability-Based Styles in Teaching and Learning

All teaching and assessment should be balanced in terms of the ability-based styles they require. At the same time, teachers need to move beyond the false dichotomy between “teaching for thinking” and “teaching for the facts” or between emphases on thinking and emphases on memory. Thinking always requires memory and the knowledge base that is accessed through the use of memory. One cannot analyze what one knows if one knows nothing. One cannot creatively go beyond the existing boundaries of knowledge if one cannot identify those boundaries. And one cannot apply what one knows in a practical manner if one does not know anything to apply.

It is for these reasons that we encourage teachers to teach and assess achievement in ways that enable students to analyze, create with, and apply their knowledge. When students think to learn, they also learn to think. And there is an added benefit to this method: Students who are taught analytically, creatively, and practically perform better

on assessments, apparently without regard to the form the assessments take. That is, they outperform students instructed in conventional ways, even if the assessments are for straight factual memory (Sternberg, Torff, & Grigorenko, 1998a, 1998b).

What, exactly, are the techniques used to teach analytically, creatively, and practically?

1. Teaching analytically means encouraging students to analyze, critique, judge, compare and contrast, evaluate, and assess. When teachers discuss teaching *critical thinking*, they typically mean teaching analytical thinking. How does such teaching translate into instructional and assessment activities? Various examples across the school curriculum are shown in Box 1.

2. Teaching creatively means encouraging students to create, invent, discover, imagine, suppose, and predict. Teaching creativity requires teachers not only to support and encourage creativity, but also to demonstrate it and reward it when it is displayed (Sternberg & Grigorenko, 2007; Sternberg & Lubart, 1995; Sternberg & Spear-Swerling, 1996; Sternberg & Williams, 1996). In other words, teachers not only need to talk the talk, they should also walk the walk. Consider some examples of instructional and assessment activities that encourage students to think creatively in Box 1.

3. Teaching practically means encouraging students to apply, use, put into practice, implement, employ, and render practical what they know. Such teaching must relate to the real practical needs of the students, not just to what would be practical for other individuals (Sternberg et al., 2000). Consider some examples in Box 1.

Thus, it is possible to implement teaching for successful intelligence in a wide variety of academic contexts. Additional examples and entire curriculum units can be downloaded for free from our website: <http://pace.tufts.edu/>.

Some Data on Teaching for Ability-Based Styles

We have sought to test the theory of successful intelligence in the classroom and determine whether teaching in different ways makes a difference in learning. Consider the following studies.

Aptitude–Treatment Interaction at the High School Level

In this set of studies, investigators explored the question of whether conventional education in school systematically discriminates against children with creative and practical strengths (Sternberg & Clinkenbeard, 1995; Sternberg, Ferrari, Clinkenbeard, & Grigorenko, 1996; Sternberg, Grigorenko, Ferrari, & Clinkenbeard, 1999). Motivating this work was the belief that systems in most schools firmly favor children with a strong memory and analytical abilities.

Sternberg et al. (1999) used the Sternberg Triarchic Abilities Test (Sternberg, 1993), an early measure of successful intelligence, to sort students according to analytical, creative, and practical ability-based styles. The test contained items measuring each of these three abilities in the verbal, quantitative, and figural domains. Assessment in the verbal domain was done using both multiple-choice and essay items. The test was administered to 326 children around the United States and to some in other countries who were identified by their schools as gifted by any standard whatsoever. Children were selected for a summer program in (college-level) psychology if they fell into one of five

ability groupings: high analytical, high creative, high practical, high balanced (high in all three abilities), or low balanced (low in all three abilities). These students, who came to Yale, were then divided into four instructional groups such that roughly equal numbers from each ability group were in each instructional group. Students in all four instructional groups used the same introductory-psychology textbook (a preliminary version of Sternberg, 1995) and listened to the same psychology lectures. However, they were each assigned to a different afternoon discussion section. Each was assigned to an instructional condition that emphasized either memory, analytical, creative, or practical instruction. For example, in the memory condition, they might be asked to describe the main tenets of a major theory of depression. In the analytical condition, they might be asked to compare and contrast two theories of depression. In the creative condition, they might be asked to formulate their own theory of depression. In the practical condition, they might be asked how they could use what they had learned about depression to help a friend who was depressed.

Students in all four instructional conditions were evaluated in terms of their performance on homework, a midterm exam, a final exam, and an independent project. Each type of work was evaluated for memory, analytical, creative, and practical quality. Thus, all students were evaluated in exactly the same way.

The results suggested the utility of the theory of successful intelligence. This utility showed itself in several ways.

First, the authors observed that when the students arrived at Yale, those in the high creative and high practical groups were much more diverse in terms of racial, ethnic, socioeconomic, and educational backgrounds than were the students in the high analytical

group, suggesting that correlations of measured intelligence with status variables such as these may be reduced by using a broader conception of intelligence. Thus, the kinds of students identified as strong in creative and practical abilities differed in terms of the populations from which they were drawn from in comparison with students identified with strong analytical abilities. It is more important to note that the investigators discovered intellectual strengths that might not have been apparent through a conventional test by simply expanding the range of abilities measured.

Second, Sternberg et al. (1999) found that all three ability tests—analytical, creative, and practical—significantly predicted course performance. When multiple-regression analysis was used, at least two of these ability measures contributed significantly to the prediction of each of the measures of achievement. One of the significant predictors was always the analytical score, perhaps reflecting the difficulty of deemphasizing the analytical way of teaching.

Third and most important, there was an aptitude–treatment interaction whereby students who were placed in instructional conditions that better matched their pattern of abilities outperformed students who were mismatched. The assessments thus fit the definition of ability-based styles proposed here. In other words, when students are taught in a way that fits the way they think, they do better in school. Children with creative and practical abilities, who are almost never taught or assessed in a way that matches their pattern of abilities may be at a disadvantage in course after course, year after year.

Teaching for Successful Intelligence in Science and Social Studies at Grades 3 and 8

If students learn best in different ways, then teaching analytically, creatively, and practically should benefit students overall because it will enable more students to

capitalize on strengths and to correct or compensate for weaknesses. A follow-up study (Sternberg et al., 1998a, 1998b) examined learning of social studies and science by third graders and eighth graders. The 225 third graders were students in a very low-income neighborhood in Raleigh, NC. The 142 eighth graders were largely middle to upper-middle class students studying in Baltimore, MD, and Fresno, CA. In this study, students were assigned to one of three instructional conditions. In the first condition, they were taught basically the same course they would have received had there been no intervention. The emphasis in the course was on memory. In a second condition, students were taught in a way that emphasized critical (analytical) thinking. In the third condition, they were taught in a way that emphasized analytical, creative, and practical thinking. All students' performance was assessed for memory learning (through multiple-choice assessments) as well as for analytical, creative, and practical learning (through performance assessments).

As expected, students in the successful-intelligence (analytical, creative, and practical) condition outperformed the other students in the performance assessments. One could argue that this result merely reflected the way they were taught. Nevertheless, the result suggested that teaching for these kinds of thinking succeeded. More important, however, was the result that children in the successful-intelligence condition outperformed the other children even on the multiple-choice memory tests. In other words, to the extent that one's goal is just to maximize children's memory for information, teaching for successful intelligence is still superior. It enables children to capitalize on their strengths and to correct or to compensate for their weaknesses, and it allows children to encode material in a variety of interesting ways.

Teaching Middle and High School Reading for Successful Intelligence

Grigorenko, Jarvin, and Sternberg (2002) extended these results to reading curricula at the middle school and high school level. In a study of 871 middle school students and 432 high school students, participants were taught language arts either through the successful intelligence theory or through the regular curriculum. At the middle-school level, reading was taught explicitly. At the high school level, reading was infused into instruction in mathematics, physical sciences, social sciences, English, history, foreign languages, and the arts. In all settings, students who were taught through the successful intelligence theory substantially outperformed students taught in standard ways (Grigorenko et al., 2002). Allowing students to bring their styles of learning to bear upon their work increases academic performance.

Teaching Mathematics to Eskimo High School Students

These principles work even in difficult-to-teach populations. In a study of Yup'ik Eskimo children in Alaska, researchers found that children who were taught using practical instruction involving fish racks, a part of their everyday lives, learned principles of perimeter and area better than did students who were taught using conventional textbook instruction (Sternberg, Lipka, Newman, Wildfeuer, & Grigorenko, 2007). For practical learners, practical teaching allows them to learn in a style that fits them and thus improves academic achievement.

Teaching for Successful Intelligence in Language Arts, Mathematics, and Science in Grade 4

The pattern of results indicating the advantage of teaching for successful intelligence has been replicated in yet another study—the largest so far (Sternberg et al.,

2007). This study was carried out on a national scale and involved thousands of fourth-grade students. We report the study in somewhat more detail because there are no previously published articles to which the reader might refer.

In this study, a group of educators and psychologists collaborated to develop and improve instructional materials and assessments in three subject areas for students in fourth grade language arts, mathematics, and science. In addition, this study was also characterized by a conservative experimental design; specifically, we compared curricula based on the successful intelligence theory with curricula based on modern theories of memory and critical thinking.

In each of these subject-matter areas, we developed several curriculum units, covering approximately a 12-week classroom intervention period. There were fewer science units than mathematics and language-arts units, but each one of these units covered a longer period. Each unit was composed of a preintervention assessment, a teacher guide, a set of activities and materials for students, and a postintervention assessment.

Each of the units in each subject area was developed in three versions, corresponding to the three educational methods (successful intelligence, critical thinking, and memory) being compared in this study. The three versions were parallel and shared the same knowledge content, but each adopted different theoretical foci to teach the content.

The pre- and postintervention assessments consisted of a set of 30 items (half multiple-choice and half open-ended) related to the unit's content. These assessments were identical for students in all three conditions. In addition to the unit-specific

assessments, a general baseline assessment was administered to all students participating in the program (either the Woodcock-Johnson III Test of Achievement, a normed test of academic achievement, or the Ohio Department of Education Proficiency Test for Grade 4).

The instructional materials consisted of an activity workbook for students and a teacher guide containing background content information and instructional guidelines. The activities were labeled according to their level of difficulty (from less challenging to more challenging), and teachers selected those activities they judged best fit the abilities of their students. Table 1 contains a list of the units developed and used in this study. Particular care was exercised to ensure that the content taught in the three versions of a unit was comparable (see Table 2, which refers to a lesson in a language-arts unit). The content of the materials was carefully aligned with national and state (for states participating in this study) standards.

Overall, 196 teachers and 7,702 students participated in the study. The study spanned 4 years, 9 states, 14 school districts, and 110 schools. The sample included primarily fourth graders, but also third and fifth graders who were taught by teachers participating in the study with their fourth graders. The number of participants was approximately equal in all experimental groups.

The analyses generally proceeded in two phases. First, we used a multifaceted Rasch analysis (FACETS) to determine scale and item characteristics, interrater reliability, and student-ability estimates. Second, student-ability estimates were subjected to hierarchical-linear modeling analyses to compare the performance of each student in each condition.

Each pre- and postinstructional assessment contained a mix of multiple-choice and open-ended items assessing creative, practical, analytic, and memory abilities specific to each unit. Open-ended items were scored by trained raters using test-specific rubrics. We used the FACETS analysis to derive ability scores that adjusted for differences in rater severity and to equate the difficulty of the pretest and posttest by anchoring items common to each test to the item's calibrated difficulty at posttest.

In addition to the total test ability score, we also derived scores for the creative–practical and analytical–memory components for each participating student. The first score represents ability-based styles proposed in particular by the theory of successful intelligence, whereas the second score represents ability-based styles proposed by conventional theories of intelligence (Sternberg, 1997a). This derivation of scores was done in a second series of FACETS analyses that used the calibrated item-difficulty estimates from the first analysis (i.e., on all items) to anchor the difficulty of the subscale items (i.e., separate analyses were run for each subset of items). This means that an individual's total pretest and posttest scores and their scores on the creative–practical and analytical–memory subscales are comparable, and more important, that gains in these scores are meaningful. This process was repeated separately for each unit and hence all scores are on the logit scale.

Hierarchical linear modeling was used to compare the gain from pretest to posttest across the three instructional conditions for each unit and for each year of implementation of the study. A three-level model was used to predict posttest scores, with the first level corresponding to individual growth from Time 1 (pretest) to Time 2 (posttest), the second level corresponding to students (demographic characteristics and baseline assessment

indicators), and the third level corresponding to teachers. Experimental condition was modeled at the teacher level. Estimated gain for a participating student was considered to be the value of the slope when predicting the posttest from the pretest. Finally, we completed a summative analysis of both samples, using a method initially proposed by Fischer (1954) for combining results from multiple samples to the presence of effect.

The item-response reliability estimates of the total test and creative–practical scores for each assessment were satisfactory ($M_s = .87$ and $.83$, medians = $.87$ and $.83$, respectively—coincidentally, the same values to two decimal places). It is interesting to note that the reliability coefficients for the analytical–memory subscales and the standardized baseline measures were consistently lower, but were still within acceptable ranges ($M_s = .70$ and $.70$, medians = $.74$ and $.70$, respectively).

To summarize the patterns of results across the two samples, we applied Fisher's product criterion, which allows us to unify different p values obtained for different units within different academic domains across multiple years of study. When considered across multiple units and the three academic domains (language arts, mathematics, and sciences), the total test scores of students in the successful-intelligence group were higher than those of students in the critical-thinking group ($p < .01$) and the memory group ($p < .05$). When considered separately for creative–practical and analytical–memory scores, however, the patterns of results were different across experimental conditions. Specifically, children in the successful-intelligence group did better on creative and practical items than did students in the critical-thinking ($p < .001$) or memory ($p < .001$) groups. Yet, when performance on analytical and memory items was considered, although the students in the successful-intelligence group differed from their peers in the

critical-thinking group ($p < .001$), they did not differ from participants in the memory group ($p = .268$). Thus, the abilities once again met our definition of ability-based styles.

To appreciate the amount of gain in each experimental condition, we averaged the slopes when predicting the posttest from the pretest for all fitted models. The results of these analyses are presented in Figure 1.

As is evident in Figure 1, all three instructional conditions demonstrated substantial gain from pretest to posttest. Yet, the results indicate that students from the successful-intelligence group generally tended to have consistently higher gain scores than did students in the control conditions.

Thus the results of these sets of studies suggest that children learn and think with different ability-based styles. Teaching in ways that recognize these individual differences improves learning.

Some Data on Ability-Based Styles in High-Stakes Assessments

The Rainbow Project

The Rainbow Project and related collaborations are fully described elsewhere (Sternberg & The Rainbow Project Collaborators, 2006; see also Sternberg & The Rainbow Project Collaborators, 2005; Sternberg, The Rainbow Project Collaborators, & The University of Michigan Business School Collaborators, 2004). The Rainbow measures supplement the SAT. The SAT is a 3-hr examination currently measuring verbal comprehension and mathematical thinking skills, with a writing component that was added to the test after we did our study. A wide variety of studies have shown the utility of the SAT as a predictor of college success, especially as measured by grade-point average (GPA).

Available data suggest reasonable predictive validity for the SAT in predicting college performance (e.g., Hezlett et al., 2001; Kobrin, Camara, & Milewski, 2002). Indeed, traditional intelligence or aptitude tests have been shown to predict performance across a wide variety of settings. But as is always the case for a single test or type of test, there is room for improvement. The theory of successful intelligence provides one basis for improving prediction and possibly for establishing greater equity and diversity. It suggests that broadening the range of skills tested to go beyond analytical skills and including practical and creative skills as well might significantly enhance the prediction of college performance beyond current levels. Thus, the theory suggests augmenting, rather than replacing, the SAT in the college admissions process. A collaborative team of investigators sought to study how successful such an augmentation could be.

In the Rainbow Project (Sternberg & The Rainbow Project Collaborators, 2006), data were collected at 15 schools across the United States, including eight 4-year colleges, five community colleges, and two high schools. The participants received either course credit or money. They were 1,013 students predominantly in their first year of college or their final year of high school. In this report, analyses only for college students are discussed because they were the only ones for whom the authors had data available regarding college performance. The final number of participants included in these analyses was 793.

Baseline measures of standardized test scores and high school GPA average were collected to evaluate the predictive validity of current tools used for college admission criteria and to provide a contrast for the current measures. Students' scores on standardized college entrance exams were obtained from the College Board.

Measuring analytical skills. The measure of analytical skills was provided by the SAT and the analytical items of the Sternberg Triarchic Abilities Test (STAT—Sternberg, 1993). The item types are shown in Box 2.

Measuring creative skills. Creative skills were measured by STAT multiple-choice items and by performance-based items. Box 2 explains how the multiple-choice items were written.

Creative skills also were measured using open-ended measures. One measure required the participant to select two potential story titles from a pool of unusual titles (such as “The Octopus’s Sneakers” and write two short stories, one required the participant to choose two picture collages and orally tell two stories based on their selection, and the third required the participant to choose cartoons from a pool and caption them. Open-ended performance-based answers were rated by trained raters for novelty, quality, and task-appropriateness. Multiple judges were used for each task, and satisfactory reliability was achieved (details in Sternberg & The Rainbow Project Collaborators, 2006).

Measuring practical skills. Multiple-choice measures of practical skills were obtained from the STAT (see Box 2). Practical skills also were assessed using three situational-judgment inventories: the Everyday Situational Judgment Inventory (Movies), the Common Sense Questionnaire, and the College Life Questionnaire, each of which taps different types of tacit knowledge. The general format of tacit-knowledge inventories has been described in Sternberg et al. (2000), so only the content of the inventories used in this study is described here. The movies from the Judgment Inventory present everyday situations that confront college students, such as asking for a letter of

recommendation from a professor who shows through nonverbal cues that he does not recognize the student very well. One then has to rate various options for how well they would work in response to each situation. The Common Sense Questionnaire provides everyday business problems, such as being assigned to work with a coworker that one cannot stand. The College Life Questionnaire provides everyday college situations for which a solution is required.

Unlike the creativity performance tasks, the participants in the practical performance tasks were not given a choice of situations to rate. For each task, participants were told that there was no “right” answer and that the options described in each situation represented variations on how different people approach different situations.

An example of a creative item might require one to write a story using the title “3516” or “It’s Moving Backward.” Another example might require one orally to tell a story inspired by a collage of pictures in which people are engaged in different a wide variety of activities helping other people. A practical item might require one to describe how he or she would handle a common academic situation as seen in a movie. For example, in one movie, a student has just received a poor grade on a test after staying up all night helping his roommate through a health crisis. His professor hands him back the test paper with a disappointed look on her face and suggests to the student that he study harder next time. Another practical item might be a written problem in which the student is asked to indicate how he or she would solve a common situation, such as a conflict with another individual with whom he or she is working on a group project, which is being adversely affected by the interpersonal conflict.

Administrative details. All materials were administered in one of two formats. A total of 325 of the college students took the test in paper-and-pencil format, and 468 students took the test on the computer via the World Wide Web. Participants were tested either individually or in small groups. During the oral stories section, participants who were tested in groups either wore headphones or were directed into a separate room so as not to disturb the other participants during the story dictation.

Basic data. When examining college students alone, this sample showed a slightly higher mean level of SAT than that found in colleges across the country. The sample means on the SATs were 490 verbal and 508 math for two-year college students and 555 verbal and 575 math for four-year college students. These means, although slightly higher than typical, were within the range of average college students.

There is always a potential concern about restriction of range in scores using the SAT when considering students from a select sample of universities, especially when the means run a bit high. Restriction of range means that one tests a narrower range of student skill levels than that which is representative of the entire population that actually takes the SAT. However, the sample was taken from a wide range of institutions, from community colleges to highly select four-year institutions. In fact, statistics assessing range showed that the sample ranged somewhat more widely than is typical for the test. Because there was no restriction of range, there was no need to correct for it.

Another potential concern is pooling data from different institutions. We pooled data because we simply did not have large enough numbers of cases in some institutions for the data to be meaningful.

Factor structure of the Rainbow measures. Some scholars believe that there is only one set of skills, sometimes called “general intelligence” or *g*, that is highly relevant to school performance (e.g., Jensen, 1998). These scholars believe that although tests may appear to measure different skills, statistical analyses show that they largely measure *g*. Does the test actually measure distinct analytical, creative, and practical skill groupings? Factor analysis addresses this question. Three meaningful factors were extracted from the data. One factor represented practical performance tests. A second, weaker factor represented the creative performance tests. A third factor represented the multiple-choice tests (including analytical, creative, and practical items). Thus, method variance proved to be very important. The results show the importance of measuring ability-based styles using multiple formats, precisely because method is so important in determining factorial structure.

Predicting college GPA. College admissions offices are not exactly interested in whether these tests predict college success. Rather, they are interested in the extent to which these tests predict college success beyond those measures currently in use, such as the SAT and high school GPA. To test the incremental validity provided by Rainbow measures above and beyond the SAT in predicting GPA, we conducted a series of statistical analyses (called *hierarchical regressions*) that included the items analyzed in the analytical, creative, and practical assessments.

If one looks at the simple correlations, the SAT-V, SAT-M, high school GPA, and the Rainbow measures all predict freshman-year GPA. But how do the Rainbow measures fare on incremental validity? Step 1 of the prediction equation in one set of analyses included the SAT-V, SAT-M, and high school GPA because these are the

standard measures used today to predict college performance. Only high school GPA contributed uniquely to prediction of college GPA. In Step 2, the analytic subtest of the STAT was added, because this test is closest conceptually to the SAT tests. The analytical subtest of the STAT slightly but significantly increased the level of prediction. In Step 3, the measures of practical ability were added, resulting in a small increase in prediction. The inclusion of the creative measures in Step 4 of this prediction equation indicates that, by supplementing the SAT and high school GPA with measures of analytical, practical, and creative abilities, a total of 24.8% of the variance in GPA can be accounted for. Inclusion of the Rainbow measures in Steps 2, 3, and 4 represents an increase of about 9.2% (from .156 to .248) in the variance accounted for over and above the typical predictors of college GPA. Inclusion the Rainbow measures without high school GPA and with only SAT scores as a base represents an 10.1% increase in variance (from .098 to .199). Looked at in another way, this means that the Rainbow measures roughly doubled prediction versus the SAT alone. Different ability-based styles of thinking, then, make a difference in predicting academic achievement beyond unitary measures of traditional general ability.

These results suggest that the Rainbow tests add considerably to the prediction resulting from SATs alone. They also suggest the power of high school GPA, particularly in prediction, because it is an atheoretical composite that includes within it many variables, including motivation and conscientiousness.

Group differences. Although one important goal of the present study was to predict success in college, another important goal involved developing measures that reduce ethnic group differences in mean levels. There has been a lively debate as to why

there are socially defined racial group differences and as to whether scores for members of underrepresented minority groups are over- or underpredicted by SATs and related tests (see, e.g., Bowen, Bok, & Loury, 2000). Might it be because different ethnic groups, on average, show different ability-based styles of thinking as a result of differential socialization? There are a number of ways one can test for group differences in these measures, each of which involves a test of the size of the effect of ethnic group. Two different measures were chosen.

First, consider numbers showing the impact of ethnic group on test scores (the *omega squared coefficients*). This procedure involves considering differences in mean performance levels among the six ethnic and racial groups reported, including European American, Asian American, Pacific Islander, Latino American, African American, and Native American (American Indian), for the following measures: the baseline measures (SAT-V and SAT-M), the STAT ability scales, the creativity performance tasks, and the practical-ability performance tasks. The coefficient indicates the proportion of variance in the variables that is accounted for by the self-reported ethnicity of the participant. The omega squared values were .09 for SAT-V, .04 for SAT-M, and .07 for combined SAT. For the Rainbow measures, omega squared values ranged from .00 to .03 with a median of .02. Thus, the Rainbow measures showed reduced values relative to the SAT.

Another test of effect sizes (Cohen's *d*) allows one to consider more specifically a representation of specific group differences. For the test of ethnic group differences, each entry represents how far each group's performance, in terms of standardized units of test scores (standard deviations), is from the mean for European Americans. For the test of

gender differences, the entries represent how far women's performances are from men's in terms of standard deviations. Results are shown in Figure 2.

These results indicate two general findings. First, in terms of overall differences, the Rainbow tests appear to reduce ethnic-group differences relative to traditional assessments of abilities like the SAT. Second, in terms of specific differences, it appears that the Latino American students benefit the most from the reduction of group differences. African American students also seem to show less of a difference from the European American mean for most of the Rainbow tests relative to other kinds of college-admissions tests, although a substantial difference appears to be maintained with the practical performance measures. Important reductions in differences from the European American means can also be seen for the Native American students. Indeed, their median was higher for the creative tests. However, the very small sample size suggests that any conclusions about Native American performance should be made extremely tentatively.

Although the group differences are not perfectly reduced, these findings suggest that researchers can design measures that reduce ethnic and socially defined racial group differences on standardized tests, particularly for historically disadvantaged groups like African American and Latino American students. These findings have important implications for reducing adverse impact in college admissions. They suggest that different groups do have, on average, different patterns of ability-based styles. Similar findings have been obtained by Fagan and Holland (2007), who found that differences in scores on ability tests were due in large part to race-specific knowledge.

Data From Other Assessment Projects

The principles behind the Rainbow Project apply at other levels of admissions as well. For example, Hedlund, Wilt, Nebel, Ashford, and Sternberg (2006) have shown that the same principles can be applied in admissions to business schools. They also found that including tests of practical thinking in addition to the Graduate Management Admission Test results in increasing prediction and decreasing ethnic- (as well as gender-) group differences.

Stemler, Grigorenko, Jarvin, and Sternberg (2006) studied the measurement of ability-based styles in the context of achievement testing. In this project, funded by the Educational Testing Service and the College Board, they asked whether the same principles could be applied to high-stakes achievement testing used for college admissions and placement. They modified Advanced Placement tests in psychology and statistics additionally to assess analytical, creative, and practical skills. Here is an example in psychology, with the corresponding skills in parentheses.

A variety of explanations have been proposed to account for why people sleep.

- a) Describe the restorative theory of sleep. (*memory*)
- b) An alternative theory is an evolutionary theory of sleep, sometimes referred to as the “preservation and protection” theory. Describe this theory and compare and contrast it with the restorative theory. State what you see as the two strong points and two weak points of this theory compared to the restorative theory. (*analytical*)
- c) How might you design an experiment to test the restorative theory of sleep? Briefly describe the experiment, including the participants, materials, procedures, and design. (*creative*)

- d) A friend informs you that she is having trouble sleeping. Based on your knowledge of sleep, what kinds of helpful (and health-promoting) suggestions might you give her to help her fall asleep at night? (*practical*)

As in the other studies, the investigators found that asking such questions enabled them to both increase the range of skills they tested and substantially reduce ethnic–group differences in test scores. Again, different ethnic groups seem to show different modal patterns of ability-based styles.

In collaboration with our colleagues from a private preparatory school (Grigorenko et al., 2006), we developed a supplementary battery of admissions assessments, which, in addition to students' SSAT (Secondary School Admission Test) scores, allowed this school to consider students' creative and practical styles. Specifically, we developed two assessments of practical competence (style) and two assessments of creative competence (style). One practical-competence task surveyed students' readiness to adapt to the new environment of a boarding school and navigate the new “rules and regulations” of a highly academically oriented and demanding prep school. In this task, students were expected to rate a number of solutions offered to them after they read a description of a practical situation. The second task included more generic situations descriptive of social aspects of student life. In this assessment, a problematic situation was depicted, and participants were asked to continue the story by identifying with the main character and developing the next step in the plot. Creative competence was also assessed with two different tasks. One task asked for a brief story using one of five proposed titles: Too Much, Too Fast; The Landing on the Planet Vespa; Third Time's the Charm; The Spy Was Not Captured After All; and When the Music

Stopped. The second task included different word problems describing various situations related to novel uses of scientific knowledge; students were asked to find a solution using some knowledge of the sciences. These four indicators were used in regression analyses predicting freshman GPA for a class of 152 students. When introduced into regression after SSAT Verbal, Quantitative, and Reading indicators, the practical-competence tasks doubled the prediction (from 12.0% to 24.4%) and the creative-competence tasks added an additional 4.4% (from 24.4% to 28.8%).

Thus, tests such as the Rainbow Assessment do not benefit only members of ethnic minority groups. There are many students who come from the majority group, and even from well-off homes, who learn in ways that are different from those assessed by conventional standardized tests. These children may well have the abilities they need to succeed in life and even in school, but these abilities may not be reflected in scores on conventional tests. Our tests help identify such students.

It is one thing to have a successful research project and another to implement the procedures in a high-stakes situation. Can any of these ideas actually make a difference in practice?

Practical Implementation

Tufts University has strongly emphasized the role of active citizenship in education. So it seemed like a suitable setting to put into practice some of the ideas from the Rainbow Project. Tufts instituted Project Kaleidoscope, which represents an implementation of the ideas of Rainbow but goes beyond that project to include the construct of wisdom in its assessment (Sternberg, 2007a, 2007b).

Tufts placed questions designed to assess wisdom, intelligence, and creativity synthesized (WICS—Sternberg, 2003b; Sternberg, 2007a) on the 2006–2007 application for all of the more than 15,000 students applying for undergraduate admissions to arts, sciences, and engineering at Tufts. The questions were optional. Whereas the Rainbow Project was administered as a separate high-stakes test with a proctor, the Kaleidoscope Project was administered as a section of the Tufts-specific part of the college application. It just was not practical to administer a separate high-stakes test such as the Rainbow assessment for admission to one university. Moreover, the advantage of Kaleidoscope is that it moved Tufts away from the high-stakes testing situation in which students must answer complex questions in very short amounts of time under incredible pressure. The section was optional this past year, and students were encouraged to answer just a single question. As examples, a creative question asked students to write stories with titles such as “The End of MTV” or “Confessions of a Middle-School Bully.” Another creative question asked students what the world would be like if some historical event had come out differently, for example, if Rosa Parks had given up her seat on the bus. Yet another creative question, a nonverbal one, gave students an opportunity to design a new product or an advertisement for a new product. A practical question queried how students had persuaded friends of an unpopular idea they held. A wisdom question asked students how a passion they had could be applied toward a common good.

So what happened? Some stakeholders were afraid that numbers of applications would go down; instead, they went up. Notably, the quality of applicants rose substantially. There were notably fewer students in what had previously been the bottom third of the pool in terms of quality. Many of those students, seeing the new application,

decided not to bother applying. Many more strong applicants applied. Other stakeholders were concerned that average SATs would go down and perhaps even plummet. Instead, they went up, rising to more than 1400 (combined verbal and math) for the first time. The reason is that the new assessments are not negatively correlated with SATs. Rather, they do not correlate much at all, one way or another. The squared correlations of the Kaleidoscope assessments with SATs were all less than .1. In contrast, squared correlations with quality of extracurricular activities were in the .4 range. Merely completing the Kaleidoscope essays had a trivial effect on admission. But students who had an “A” (top rating) on the Kaleidoscope assessments were twice as likely to be admitted as were those who did not. There were no significant ethnic-group differences in rated Kaleidoscope performance. Moreover, after 1 year, students with top Kaleidoscope ratings performed just as well academically as students equated for academic strength who did not have top Kaleidoscope ratings but were admitted primarily for other reasons. The assessments provided a quantified way of assessing ability-based styles of thinking that, in the past, had been assessed only in a more qualitative way. We note that all of these results are correlational, not causal, so that one cannot conclude that Kaleidoscope was the cause of any differences obtained in the past year.

In sum, adopting these new methods results in the admission of applicants who are more qualified, but in a broader way than was considered in the past. Perhaps most rewarding were the positive comments from large numbers of applicants, irrespective of whether they were later accepted or not, who felt our application gave them a chance to show themselves for who they are.

After a number of years in which applications by underrepresented minorities were relatively flat in terms of numbers, this year they went up substantially. In the end, Tufts admitted roughly 30% more African American students than the year before and 15% more Latino Americans. So these results, like those of the Rainbow Project, showed that it is possible to increase academic quality and diversity simultaneously and that it can be done for an entire undergraduate class at a major university, not just for small samples of students at some scattered colleges. Most important, the university sent a message to students, parents, high school guidance counselors, and others that it believes that there is a more to a person than the narrow spectrum of skills assessed by standardized tests and that these broader skills can be assessed in a quantifiable way.

One might wonder how one assesses answers to questions that seem so subjective. The answer is through well-developed rubrics. For example, we assess analytical responses on the extent to which they are analytically sound, balanced, logical, and organized. We assess creative responses on how original and compelling they are, as well as on their appropriateness to the task originally presented to the students. We assess practical responses on the basis of how feasible they are with respect to time, place, and both human and material resources. We assess wisdom-based responses on the extent to which they promote a common good by balancing one's own interests with others' and with larger interests over the long and short terms through the infusion of positive (prosocial) values.

Integration

In sum, ability-based styles can make a difference to instruction and assessment. In particular, the theory of successful intelligence can be used to help students to

capitalize on strengths and compensate for or correct weaknesses so that they are able to improve their school achievement.

PERSONALITY-BASED STYLES: MENTAL SELF-GOVERNMENT

In the previous sections, we discussed ability-based styles based on the theory of successful intelligence. In the following sections, we discuss personality-based styles derived from another theory, the theory of mental self-government (Sternberg, 1988, 1997b).

Understanding personality-based styles helps teachers differentiate instruction so as to maximize the learning outcomes of all learners (Sternberg, 1997b, 2003a; Sternberg & Grigorenko, 1997, 2004; Zhang & Sternberg, 2000, 2005, 2006). Styles can apply at any level from elementary school (e.g., Sternberg & Grigorenko, 1995) through the university level (Cilliers & Sternberg, 2001).

A personality-based style of thought is a preference for using abilities in certain ways. It is not an ability itself, but rather, how one likes to use one's abilities. Thus, when we speak of individual differences in personality-based thinking styles, we are speaking only of differences and not in terms of what is "better" or "worse."

Personality-based styles of thought are important in education from several points of view. First, if abilities as we currently measure them account for only small proportions of individual differences in school performance, then we might ask what other kinds of constructs might account for what is not predicted (see Gardner, 1993; Sternberg, 1985). Personality-based thinking styles, we argue, provide one such construct.

Sometimes the pattern of personality-based styles that leads to success in a course in a given discipline is not the pattern of personality-based styles that leads to actual success later in a job in that discipline. As a result, we may give the best grades to students who will later not be particularly successful in a given field and derail other students who might be very successful but will never have the chance to prove it because of low course grades.

Some General Characteristics of Personality-Based Styles

Before proceeding, we wish to outline some general characteristics of personality-based styles of thought (Sternberg, 1997b). First, personality-based styles are preferences. For example, there is a difference between how creative a student is (ability-based style) and how much the student likes to be creative (personality-based style). Second, personality-based styles are not “good” or “bad,” but rather matters of fit between learner and teacher or learner and material. What one teacher considers a good personality-based style, another may consider bad, and vice versa. Third, personality-based styles can vary across tasks and situations. People vary their personality-based styles, at least somewhat, to fit what they are doing. They do not have one fixed style. Fourth, people differ in strengths of personality-based stylistic preferences. Some people strongly prefer certain styles whereas others have only weak preferences. Fifth, people differ in their personality-based stylistic flexibility. Some people easily can switch among styles; others cannot. Sixth, personality-based styles are socialized. Styles are learned through interactions with the environment. Seventh, personality-based styles can vary across the life span—they are not fixed. People may change their styles over the years. Eighth, personality-based styles are modifiable. People are not “stuck” with certain personality-

based styles unless they want to be. Tenth, what is valued in one time and place may not be valued in another. Environments almost invariably tend to favor certain personality-based styles over others. The very personality-based style that leads to success in one school or one job may lead to failure in another.

Many alternative theories of personality-based styles have been proposed (Biggs, 1987, 1988; Entwistle, 1981; Gregorc, 1979, 1985; Holland, 1973; Jung, 1923; Marton, 1976; Myers, 1980; Myers & McCaulley, 1988), and a number of those are reviewed in Grigorenko and Sternberg (1997), Sternberg (1997b), Sternberg and Grigorenko (2001), and Sternberg and Zhang (2001). Lack of space prevents a detailed review here. In this article, we concentrate on one theory: mental self-government.

The Theory of Mental Self-Government

The theory of mental self-government (Grigorenko & Sternberg, 1995; Sternberg, 1988, 1990, 1994, 1997b, 2001, 2003a; Sternberg & Grigorenko, 1995, 1997; Sternberg & Zhang, 2001) holds that personality-based styles can be understood in terms of constructs from our notions of government. In this view, the kinds of governments we have in the world are not merely coincidental, but rather are external reflections or mirrors of ways in which we can organize or govern ourselves. According to this theory, people can be understood in terms of the functions, forms, levels, scope, and leanings of government.

Functions

There are three functions of government in the theory: legislative, executive, and judicial. Each style is described below.

Legislative. The legislatively oriented student has a predilection for tasks, projects, and situations that require creation, formulation, planning of ideas, strategies, products, and the like. This kind of student likes to decide what to do and how to do it, rather than to be told. For example, the student who likes creative writing, designing experiments, coming up with theories about things, creating original artistic compositions, or inventing new things would tend toward the legislative. Three examples of assignments that would appeal to legislatively oriented children would be writing a creative story in an English lesson, inventing a new mathematical operation in a mathematics lesson, and writing an anticipated “future history”—a predicted description of events to come—in a history class.

Executive. The executively oriented student has a predilection for tasks, projects, and situations that provide structure, procedures, or rules to work with and that, although modifiable, can serve as guidelines to measure progress. Whereas the legislatively oriented student likes to decide what to and how to do it, the executively oriented student will often prefer to be told what to do and will then give it his or her best shot at doing it well. For example, the kind of pupil who likes to follow directions in doing school assignments, build models or design things according to instructions, write papers on assigned topics, be given problems to solve, or implement the orders of others would tend toward the executive style. Three examples of assignments that would appeal to primarily executively oriented children would be memorizing state capitals in a geography class, learning number facts in an arithmetic class, and learning the names of rocks in an earth science class.

Traditional teaching may most strongly reward the executive style. Good students are often seen as those who do what they are told and do it well. Legislative students may have the same abilities, but the abilities may not manifest themselves, and such students may actually be viewed as “pains in the neck.” The student leaning toward the executive style will take naturally to memorizing given material, taking multiple-choice or short-answer tests, and doing assignments in ways that teachers expect. Legislatively oriented students are less likely to take naturally to multiple-choice and short-answer tests and would probably rather work on projects than take exams. They may therefore be penalized by conventional instruction and assessments because of their preference for a creative way of thinking.

Judicial. The judicially oriented student has a predilection for tasks, projects, and situations that require evaluation; analysis; comparison and contrast; and judgment of existing ideas, strategies, projects, and the like. This student tends to be evaluative of others, sometimes on the basis of minimal information. The judicially oriented student tends to like evaluative essays, writing critiques, commenting on other people’s ideas, and assessing others’ strengths and weaknesses. Three examples of assignments that would appeal to judicially oriented students would be analyzing how different nations have different conceptions of democracy in the context of a government class, evaluating the validity of a theory of the extinction of the dinosaurs in a biology class, and comparing and contrasting two characters from a novel—for example, Alyosha and Ivan Karamazov—in a literature class.

Forms

There are four different forms of mental self-government in the theory: monarchic, hierarchic, oligarchic, and anarchic.

Monarchic. The monarchically oriented student has a predilection for tasks, projects, and situations that allow complete focus on one thing or aspect at a time until it is complete. A monarchically oriented student is single-minded and often driven, preferring to finish one thing before moving on to the next. This style is usually easy to recognize in students or in teachers, for that matter, because the person using this style tends to be so devoted to a single thing. A teacher can help a monarchically oriented student by relating whatever the student is extremely interested in to the work that needs to be done in class. For example, if a student is fascinated with computers, the teacher might find a way to relate her assignment to computers. Some examples of monarchically oriented students would include one who devotes very large chunks of time to using the Internet, one who loves mathematics to the exclusion of all other subjects, and one who is dedicated to tennis and spends as much time as possible playing it.

Hierarchic. The hierarchically oriented student has a predilection for tasks, projects, and situations that allow creation of a hierarchy of goals to fulfill. These students like to do multiple things in a given time frame, but they assign differential priorities for getting them done. These students will often make lists and sometimes lists of lists. They tend to be adaptive in many settings where it is necessary to set priorities for getting certain things done before others or where it is necessary to decide that some things are more worthy of attention than are others. For example, students with this style are able to set priorities for getting their various homework assignments done or for

deciding how to allocate time in a speeded test. Some examples of hierarchically oriented students include one who allocates time to homework assignments that are due sooner rather than later, a student who allocates time on a test to those sections the teacher has said will count more toward the final grade, and one who carefully allocates time to practicing different pieces for an anticipated piano audition in terms of how likely it is that she will be to be asked to play them.

Oligarchic. The oligarchically oriented student has a predilection for tasks, projects, and situations that allow working with competing approaches or with multiple aspects or goals that are equally important. This student, like the hierarchically oriented one, likes to do multiple things within a given time frame but has trouble setting priorities for which to get done when. The oligarchically oriented student thus adapts well if the competing demands all have roughly equal priority but has more trouble if they have different priorities. Students who cannot decide which assignments to do first or how much time to put into each assignment or professors who can not decide how to budget their time may lean toward the oligarchic style. Often, a teacher can help an oligarchically oriented student simply by helping that student set priorities for schoolwork. Some examples of oligarchically oriented students include one who does not put in the effort to decide how much time to spend on different test items and instead spends roughly equal time on them all of them, even though they do not count the same; one who does homework haphazardly without regard to when assignments are due and finishes some assignments well ahead of schedule and others well behind schedule; and one who fails to set priorities for her personal versus her school life and has trouble keeping up in school because she spends so much time going out with fellow students.

Anarchic. The anarchically oriented student has a predilection for tasks, projects, and situations that lend themselves to great flexibility of approaches and to trying anything when, where, and how he or she pleases. This student tends to be asystematic or even antisystematic. The individual tends to take a random approach to problems and is sometimes difficult for other people to understand. The anarchically oriented student may have good potential for creativity because the individual draws ideas from so many places, but to exploit this potential, the pupil usually needs somehow to discipline him- or herself. Anarchically oriented students often have trouble in school settings, and with authority in general, because they do not naturally tend toward self-organization and self-discipline. Teachers can help anarchically oriented students by helping them organize themselves and channel their creativity constructively. Some examples of anarchically oriented students include one who does not keep track of what assignments are due when and so rarely gets them in on time, one who cannot organize himself to study for tests, and one who is potentially extremely creative but fails to learn the material ideas adequately.

Levels

There are two levels of mental self-government: local and global.

Local. The locally oriented student has a predilection for tasks, projects, and situations that require engagement with specific, concrete details. These students like to work with the nitty-gritty, but they may lose the forest for the trees. Students displaying this style tend to enjoy tasks that require them to keep track of details and focus on concrete specifics of a situation. Some examples of students with a local style include one who learns many details when studying for tests but does not understand how they

interrelate, another who writes papers that show a great knowledge of facts but that have no clear organizing superstructure, and one who makes it clear she cannot see the forest for the trees during her talks—she concentrates on specifics without any overview of her topic.

Global. The globally oriented student has a predilection for tasks, projects, and situations that require engagement with large, global, abstract ideas. These students like to deal with big ideas, but they may sometimes lose touch with the details—they may see the forest but lose track of the trees. Students using this style enjoy tasks that encourage them to think about major ideas and not worry about details. Some examples of globally oriented students include one who makes many global assertions when writing papers but fails to support them with specific evidence, one who does very well in comprehending main ideas of passages but poorly in comprehending details, and one who shows very good musicality and interpretation when playing music but makes many mistakes in intonation.

Scope

There are two scopes of mental self-government: internal and external.

Internal. The internally oriented student has a predilection for tasks, projects, and situations that require activities that allow one to work independently of others. This individual prefers to work alone, is typically introverted, and is often uncomfortable in groups. This student generally prefers individual study to work groups. Some examples of internally oriented students include one who likes to study for tests by himself, one who routinely turns down invitations to go to student parties because she feels

uncomfortable interacting with others, and one who does not speak out in groups because she is reluctant to interact with the others in the group.

External. The externally oriented student has a predilection for tasks, projects, and situations that allow working with others in a group or interacting with others at different stages of progress. This student prefers to work with others, is typically extraverted, and is very comfortable in group settings. Whereas the internally oriented student will probably shy away from cooperative learning, this student will take naturally to it. Indeed, this student might not enjoy working alone or even being alone. Thus, methods of teaching that lead some students to feel quite comfortable can make other students quite uncomfortable. Some examples of externally oriented students include one who strongly prefers working in groups to working individually, one who hates to spend time alone and constantly needs to be with others, and one who is effective studying with others but not alone.

Leanings

There are two leanings of mental self-government: liberal and conservative.

Liberal. The liberally oriented student has a predilection for tasks, projects, and situations that involve unfamiliarity, going beyond existing rules or procedures, and maximization of change. Sometimes the individual may prefer change simply for the sake of change, even when it is not ideal. Students displaying a liberal style like new challenges and thrive on ambiguity. Some examples of liberally oriented students include one who resents having to do things in traditional ways, almost without regard to the situation; one who is constantly seeking alternative and nonobvious ways of solving

physics problems; and one who loves writing poetry that is unusual in both style and content.

Conservative. The conservatively oriented student has a predilection for tasks, projects, and situations that require adherence to existing rules and procedures. This individual likes to minimize change and avoid ambiguity. Some examples of conservatively oriented students include one who frequently asks the teacher exactly what is expected, one who takes his lead from other students as to how to do assignments, and one who feels very anxious when expected to do a project in an art class using new media for creating artistic works.

Personality-Based Styles in the Classroom

We have conducted several studies investigating styles in elementary, secondary, and college classrooms (see Sternberg, 1994, 1997b; Sternberg & Grigorenko, 1995; Zhang & Sternberg, 2001, 2002). We describe here the results of selected studies.

Researchers have tested the theory of mental self-government through a number of related inventories, with the Thinking Styles Inventory (TSI, Sternberg & Wagner, 1991) used most frequently. The TSI is a self-report test consisting of 65 statements. Each of the 13 thinking styles is assessed by five statements. For each statement, the participants rated themselves on a 7-point Likert scale, with 1 indicating that the statement does not at all describe the way they normally carry out tasks and 7 denoting that the statement very accurately characterizes the way they normally carry out tasks. An example of an item might be “I prefer tasks that are well-structured” (executive style) or “I prefer to do things in ways that are tried and true” (conservative style).

The Thinking Styles in Teaching Inventory (TSTI) is a 49-item self-report questionnaire in which teachers rate themselves on a 7-point response scale, with 1 denoting that the statement does not at all describe the way they normally carry out teaching tasks and 7 denoting that the statement very accurately describes the way they normally carry out teaching tasks. The instrument was designed to assess seven thinking styles that teachers use in teaching: legislative, executive, judicial, global, local, liberal, and conservative. Each style is assessed by seven items that constitute one scale. Two sample items are: “I like students to plan an investigation of a topic that they believe is important” (legislative style), and “Each year I like to select new and original materials to teach my subject” (liberal style).

The Preferred Thinking Styles in Teaching Inventory (PTSTI) is composed of 65 statements divided into sets of 5 statements, with each set contributing to the measurement of students’ preferences for one of the 13 thinking styles in teaching, as described in the theory of mental self-government. For each statement, the participants rated themselves on a 7-point response scale, with 1 indicating that they absolutely disagree that the statement describes the way that they prefer their teachers to carry out tasks in their educational practice and 7 denoting that they absolutely agree that the statement describes the way that they prefer their teachers to carry out tasks in their educational practice. Here are two sample items: “It is important that teachers allow students to generate their own topics for a written assignment” (legislative style), and “Good teachers provide students with step-by-step guidelines for completing their assignments” (executive style).

Styles of Teachers

Teachers also have preferred personality-based styles. It is important to understand these styles because, as we show, they interact with the styles of learners to produce better or worse outcomes in school.

In an initial study in four schools of widely varying types (private and public, and socioeconomically diverse) in the United States, Sternberg and Grigorenko (1995) found several interesting effects with respect to grade taught, age of teachers, subject area taught, and ideology.

Teachers are more legislative but less executive at the lower grades than at the upper grades. These findings might suggest either that more legislative individuals are attracted toward teaching at the lower grade levels, or that people teaching at the lower grade levels become more legislative (or that those teaching at the upper grade levels become more executive). The demands on teachers in the U.S. are consistent with this pattern of findings: Teachers in the upper grades are forced to follow a more rigidly prescribed curriculum than are teachers in the lower grades.

Sternberg and Grigorenko (1995) also found older teachers to be more executive, local, and conservative than younger teachers. Again, there are two interpretations of these findings, either or both of which might be correct. One interpretation is that teachers become more executive, local, and conservative with age; the other interpretation is that the difference is due to a cohort effect.

They also found science teachers to be more local than teachers of the humanities, whereas the latter tended to be more liberal than the former. These results again are roughly consistent with our experience. With respect to science, the results unfortunately

suggest that science teachers may concentrate substantially more on the local details of science than on the “big picture” of scientific research.

Finally, the authors did an analysis of the relation of school ideology to teachers' styles. Sternberg and Grigorenko (1995) had a rater unfamiliar with the individual teachers in each school rate each school for its own profile of styles on the basis of catalogues, faculty and student handbooks, statements of goals and purposes, and curricula. They also evaluated teachers' styles, and then contrasted the match between teachers and schools. For six of seven planned contrasts, they found significant effects. In other words, teachers tend to match the stylistic ideology of their schools. Either teachers tend to gravitate toward schools that fit them ideologically, or else they tend to become like the place they are in, suggesting again the importance of socialization in the formation of styles, even at the adult level.

In another study, Zhang and Sternberg (2002) administered the Thinking Styles in Teaching Inventory to 193 in-service teachers studying in the Bachelor of Education degree program and the Postgraduate Certificate in Education program at the University of Hong Kong. They found that teachers' thinking styles in teaching (i.e., teaching styles) significantly differed as a function of their professional work experience (as measured by duration) outside school settings, the degree to which they enjoyed adopting new teaching materials, the extent to which they use group projects in assessing students' achievement, the degree of autonomy they believed they had in determining the contents of their teaching, and the confidence they placed on the quality of the students they were teaching.

Teachers' professional work experience outside school settings was positively related to scores on the judicial and liberal thinking styles. These results suggested that teachers who had had more experiences beyond their experience in school settings were more likely to be judicially engaged in the evaluation of their students' tasks. Furthermore, these teachers tended to gain more satisfaction from working in situations in which novelty and ambiguity are involved.

This result is, in fact, consistent with the previous research finding that rich experiences can have positive effects on people's thinking (e.g., Astin, 1989; Petersen, Leffert, & Graham, 1995; Zhang, 1999). For example, Zhang (1999) found that university students who had had more work and traveling experiences scored significantly higher on the judicial, liberal, and hierarchical styles.

Teachers' reported enjoyment of adopting new teaching materials was positively related to the legislative and liberal styles but negatively related to the use of the conservative teaching style. Further, teachers who reported more use of group projects were significantly more legislative than were those who reported less use of group projects.

The degree of autonomy that teachers believed they were allowed in determining the content of their teaching had the strongest relationship with the judicial style. This indicated that teachers who perceived more autonomy in their teaching were more likely to be engaged in such mental activities as comparison and evaluation (i.e., using the judicial teaching style).

Finally, teachers who expressed higher levels of confidence in the quality of their students tended to think more globally about their teaching. Perhaps teachers with better students simply can afford to be more global in their approach to their task.

Zhang (2001) took a step further to examine how teachers' thinking styles in teaching are related to their teaching approaches. Teaching approaches were assessed by Trigwell and Prosser's (1996) Approaches to Teaching Inventory, which is also a self-report test. Containing 16 items, it assesses two different teaching approaches: student-centered (also known as the conceptual-change approach) and teacher-centered (also known as the knowledge-transmission approach).

Participants in this study were 76 in-service teachers from the Faculty of Education at the University of Hong Kong. On the basis of the teaching styles defined in Sternberg's theory of mental self-government and on the two teaching approaches defined in Trigwell and Prosser's model, we predicted that teachers who reported taking a student-focused approach to teaching would score significantly higher on teaching styles associated with creativity—including the legislative, judicial, global, and liberal styles—whereas teachers reporting a teacher-focused teaching approach would score significantly higher on the teaching styles that elicit conformity to norms—the executive, local, and conservative styles. The results fully supported this prediction.

Styles of Students

Sternberg and Grigorenko (1995) tested 124 students between the ages of 12 and 16 distributed among four schools and found some interesting demographic effects. Socioeconomic level related negatively to the judicial, local, conservative, and oligarchic styles. These results are consistent with a notion of greater authoritarianism in the styles

of individuals of lower socioeconomic class and lower education levels (Adorno, Frenkel-Brunswik, Levinson, & Sanford, 1950). They also found that later-born siblings tend to be more legislative than are earlier-born siblings, which is consistent with the past finding that firstborns tend to be more accepting of societal dictates than are later-born children (Simonton, 1988). Finally, they found a significant degree of match between students' and teachers' styles. Whereas the match between teachers' styles to the profile of their schools could be interpreted in terms of choice of school, such an explanation is implausible in the case of students, who rarely get to choose their school. The results suggest socialization of styles.

In a further study, Sternberg and Grigorenko (1995) went back to one of the original questions that motivated this work: Do students perform better in classrooms where their styles match the styles of their teachers? They assessed students' and teachers' styles and found that, indeed, students performed better and were more positively evaluated by teachers when their styles matched the styles of their teachers than they did when the styles mismatched. In other words, the students performed better when they were more like their teachers stylistically, independent of actual level of achievement.

Similarly, in several studies conducted among students in Hong Kong and mainland China, researchers also found evidence for socialization of styles. In one such study (Zhang & Postiglione, 2001), investigators examined the relationships of students' thinking styles to their reported socioeconomic status (SES). Participants were 694 undergraduate students from the University of Hong Kong. Researchers used three measures to determine SES. The first one was parental educational level, the second was

family income, and the third was the participants' physical home environments. The researchers found that students from higher SES families scored significantly higher on the styles associated with creativity and that students from lower SES families scored significantly higher on the conservative style.

In several studies, researchers addressed the question of whether thinking styles contribute to academic achievement beyond abilities? For example, in one study, Zhang and Sternberg (1998) examined the contributions of thinking styles to academic achievement beyond students' self-rated analytical, creative, and practical abilities (Sternberg, 1985). Research participants were 622 rising freshmen from the University of Hong Kong. The achievement measure was the participants' scores on the Advanced Level Tests (A-Level Tests) that serve as the university entrance examinations in Hong Kong. Test scores in 13 subject matters were used: applied mathematics, biology, Chinese language and culture, chemistry, Chinese history, Chinese literature, economics, geography, history, statistics, physics, pure mathematics, and use of English. The investigators found that thinking styles predicted students' achievement in the majority of the subject matters beyond self-rated abilities. Moreover, the kinds of thinking styles that tended to be positively associated with the A-Level achievement test scores were the ones that require conformity (conservative style), an orientation toward a sense of order (hierarchical style), and a preference for working independently (internal style). They also found that the legislative and liberal styles and the external style were more likely to be negatively predictive of students' achievement scores. In other words, in Hong Kong, more traditional students who did what they were told seemed to achieve at higher levels.

Finally, Zhang (2006) examined the preferences for teachers' teaching styles among university students from three cultures—Hong Kong ($n = 155$), mainland China ($n = 256$), and the United States ($n = 81$)—and used the Preferred Thinking Styles in Teaching Inventory to assess these preferences. Zhang found strikingly similar results among the three groups of students. All three groups preferred that their teachers teach in styles that would generate creative thinking among students (e.g., legislative, liberal) and that teachers facilitate interactions among students (external style). That is, students from all three cultures expressed the strongest preference for teaching styles that could provide them with opportunities to develop their creative thinking, to increase their level of cognitive complexity, and to work collaboratively with others. Moreover, students from all three cultures also shared a commonality regarding the teaching styles they appreciated the least. These are the old fashioned (conservative) and monotonous (monarchic) teaching styles that require students to do multiple tasks without communicating the priority of the tasks (oligarchic style) and that are not conducive to collaborative work (internal style).

Integration

For those who teach and assess students at any level—young children, adolescents, or adults—the theory of mental self-government implies modes of rendering teaching more effective through style-differentiated instruction. The key principle is that for students maximally to benefit from instruction and assessment, at least some of each of instruction and assessment should match their styles of thinking. We do not advocate a perfect match all the time: Students need to learn, as does everyone, that the world does not always provide people with a perfect match to their preferred ways of doing things.

Flexibility is as important for students as for teachers. But if we want students to show what they truly can do, match of instruction and assessment to styles is essential.

There can be synergies between ability-based and personality-based styles. For example, students with an executive style and high memory abilities, a legislative style and high creative abilities (O'Hara & Sternberg, 2001), or a judicial style and high analytical abilities will be at an advantage because the kinds of skills at which they excel match the kinds of ways they like to think (Sternberg & Grigorenko, 1997).

CONCLUSIONS

Ability-based and personality-based styles matter. In teaching, we need to take into account students' styles of thinking if we hope to reach them. This means differentiating instruction in a way that helps students capitalize, at least some of the time, on their stylistic preferences. Students need to learn both how to capitalize on strengths and to correct or compensate for weaknesses.

We need to consider carefully how our practices in educational settings may deprive able people of opportunities, while giving opportunities to those who are less able. For example, extensive use of multiple-choice testing in the U.S. clearly benefits executive thinkers. But replacing all of those tests with projects and portfolios would simply result in a different group of students being benefited. Ideally, we need to teach to and assess a variety of styles.

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Fig 1. Estimated gain in total score (T), creative–practical score (CP), and analytical–memory score (AM) as a function of instructional condition. SI = successful intelligence condition; CT = critical thinking condition; M = memory condition.

Fig 2. Amount of each Rainbow measure that is predicted by racial/ethnic differences. STAT = Sternberg Triarchic Abilities Test.

¹In this article, we use the term *style* somewhat differently from the way we have used it in our past writings. Here, we use it to refer either to a maximum-performance (“ability-

based”) or typical-performance (“personality-based”) difference or preference in learning or thinking that can lead to differential outcomes in instruction and assessment.