TEACHING FOR

Wisdom, Intelligence, Creativity, and Success

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Contents

List of Tables

Preface

Acknowledgments

About the Authors

PART I. TEACHING FOR WISDOM, INTELLIGENCE, CREATIVITY, AND SUCCESS

1. Introduction to Teaching for Wisdom, Intelligence, Creativity, and Success
2. What Is the WICS Model?
3. Your Turn: What Is Your Pattern of Strengths?

PART II. WHY AND HOW TO TEACH FOR SUCCESSFUL INTELLIGENCE

4. Introduction to Teaching for Successful Intelligence
5. How to Enhance Memory Skills
6. How to Enhance Analytical Skills
7. How to Enhance Creative Skills
8. How to Enhance Practical Skills
9. Your Turn: Identify Different Types of Teaching Strategies

PART III. INTEGRATING TEACHING AND ASSESSMENT IN YOUR CLASSROOM

10. Introduction to Integrating Teaching and Assessment
11. Matching Assessment and Instruction

12. General Guidelines for Developing Diversified Assessments
13. Assessing and Rating Memory Skills
14. Assessing and Rating Analytical Skills
15. Assessing and Rating Creative Skills
16. Assessing and Rating Practical Skills
17. Your Turn: Develop Different Types of Assessment Questions

PART IV. WHY AND HOW TO TEACH FOR WISDOM

18. Introduction to Teaching for Wisdom
19. Three Wisdom-Based Thinking Skills
20. Six General Guidelines for Teaching Wisdom
21. Reflection: How Can You Promote Wise Thinking in Your Classroom?

PART V. SYNTHESIS: HELPING STUDENTS ACHIEVE SUCCESS AND SATISFACTION IN THEIR LIVES

22. Introduction to Achieving Balance
23. How to Balance It All
24. A Word of Wisdom on Learning Goals
25. Wisdom, Intelligence, and Creativity, Synthesized

Answer Key

Appendix to Part I: Suggested Further Readings

Appendix to Part II: Mnemonic Techniques and Strategies

Appendix to Part III: Cross-Reference of Sample Tables

References

Index

List of Tables

Part II. Chapter 6

Table 1. Analytical Activity From an Elementary School Lesson on the Mystery Genre

Table 2. Analytical Activity From a High School Lesson Accompanying the Reading of H. G. Wells's *The Island of Dr. Moreau*

Table 3. Analytical Activity From an Elementary School Lesson on Properties of Materials

Table 4. Analytical Activity From a High School Physics Lesson on Atoms

Table 5. Analytical Activity From an Elementary School Lesson on Number Sense and Place Value

Table 6. Analytical Activity from a High School Lesson on the Statistical Concepts of Mean, Median, and Mode

Table 7. Analytical Activity From a High School Lesson on Psychology

Table 8. Analytical Activity From a Middle School Lesson on Conflict Resolution

Part II. Chapter 7

Table 9. Creative Activity From an Elementary School Lesson on the Genre of Tales

Table 10. Creative Language Arts Activity From a High School Lesson on the Literary Movement of Romanticism

Table 11. Creative Activity From an Elementary School Science Lesson on Sound

Table 12. Creative Activity From a High School Lesson on Vectors

Table 13. Creative Activity From a Mathematics Unit on Equivalent Fractions

Table 14. Creative Activity From an Elementary School Math Lesson on Data Analysis and Representation

Table 15. Creative Activity From a Middle School Lesson on Numbers

Table 16. Creative Activity From a High School Lesson on Psychology

Table 17. Creative Activity From a High School Lesson on World Cultures

Part II. Chapter 8

Table 18. Elementary School Language Arts Concepts That Lend Themselves to Instruction in the Practical Mode

Table 19. Practical Activity From a Lesson Accompanying the Reading of Harper Lee's *To Kill A Mocking Bird*

Table 20. Practical Activity From an Elementary School Lesson on Ecology

Table 21. Practical Activity From a High School Physics Lesson on Vectors and Scalars

Table 22. Practical Activity From an Elementary School Lesson on Measurement

Table 23. Practical Activity From a High School Lesson on Prime and Composite Numbers

Table 24. Practical Activity From a High School Lesson on Psychology

Table 25. Practical Activity From a Middle School Lesson on "The Birth of the Nation"

Part II. Chapter 9

Table 26. Culminating Quiz

Part III. Chapter 12

Table 27. Determining the Most Important Concepts and Skills Addressed in a Curriculum Unit: An Illustration From a Fourth Grade Science Unit on Light

Table 28. Step 1: Develop Your Own Lesson Plan

Table 29. A 5-Point Proficiency Scale for Items Assessing Memory Skills in Mathematics

Table 30. Develop Your Own Assessment Questions

Part III. Chapter 13

Table 31. Rubric for Attributing a Score to a Language Arts Memory Assessment Item From an Elementary School Lesson on the “Wonder Tales” Genre

Table 32. High School Physics Item Primarily Assessing Memory Skills

Table 33. Elementary School Mathematics Item Primarily Assessing Memory Skills

Part III. Chapter 14

Table 34. Rubric for Rating Responses to an Elementary School Language Arts Assessment for Analytical Abilities

Table 35. Rubric for Rating Elementary School Students’ Responses to Open-Ended Science Questions

Table 36. Rubric for Rating Analytical Skills in Elementary School Students’ Responses to a Science Question

Table 37. Rubric for Rating an Open-Ended Analytical Question From a High School Statistics Lesson

Part III. Chapter 15

Table 38. Rubric for Attributing a Score to a Language Arts Creative Assessment Item

Table 39. Rubric for Rating Creative Ability on an Open-Ended Elementary School Science Creative Assessment Item

Table 40. Open-Ended Assignment for Assessment of Creative Thinking in a High School Mathematics Lesson on Algebra

Part III. Chapter 16

Table 41. Rubric for a Language Arts Assessment Primarily Addressing Practical Skills

Table 42. Rubric for a Middle-School Science Assessment Primarily Addressing Practical Skills

Table 43. Open-Ended Assignment Primarily Tapping Into Students' Practical Skills

Part III. Chapter 17

Table 44. Develop Your Own Rubric With Sample Student Responses

Part IV. Chapter 18

Table 45. Four Reasons Why Schools Should Include Instruction in Wisdom-Based Thinking Skills in Their Curriculum

Part IV. Chapter 19

Table 46. Reflective Thinking: Self-Monitoring Checklist for Students

Part IV. Chapter 20

Table 47. Six General Guidelines for Teaching for Wisdom

Table 48. Activity From Lesson on Values

Table 49. Activity From the Unit "How Slavery Arrived in the New World"

Table 50. Activity on the Use of Arguments Versus Emotions in Convincing Others

Table 51. Useful Questions to Ask Yourself When You Are Trying to Solve a Dilemma

Part V. Chapter 23

Table 52. Balancing Analytical, Creative, and Practical Activities in an Elementary/Middle School Science Unit on Light

Table 53. Balancing Analytical, Creative, and Practical Activities in a High School Art Unit on the Nineteenth Century Impressionist Movement

Table 54. Balancing Analytical, Creative, and Practical Activities in an Elementary School Language Arts Unit on the Biography Genre

Table 55. Balancing Analytical, Creative, and Practical Activities in a High School Mathematics Unit on the Properties of Exponents

Table 56. Thinking Verbs

Table 57. Analytical, Practical, and Creative Items From an Elementary School Homework Assignment in Mathematics on Number Sense

Table 58. Analytical, Practical, and Creative Items From a High School Assessment in Psychology

Part V. Chapter 24

Table 59. Summary of Steps to Follow in Designing a Lesson Plan or Unit

Part V. Chapter 25

Table 60. Template A for Lesson Design

Table 61. Template B for Lesson Design

Table 62. Sample Checklist to Review Lesson or Textbook Content for Balance and Standards Met

Preface

About This Book

This book aims to bring together some of the enduring themes and most significant work of Robert J. Sternberg and his collaborators at the Center for the Psychology of Abilities, Competencies, and Expertise (PACE), a center originally at Yale University and now at Tufts University. The book offers a rationale and suggestions for K–12 instruction and assessment based on Sternberg's theories, and the empirical work based on these theories, to foster in students the capacity for wise, successfully intelligent, and creative learning, problem solving, and living. This book represents an overview of roughly a dozen years of collaborations with teachers in different grade levels all across the United States and abroad. We are grateful to all the collaborators we have had over the years, and dedicate this book to the teachers with whom we have worked.

The book comprises five main parts, providing (1) an introduction, (2) a guide on how to teach for successful intelligence, (3) a guide on how to assess for successful intelligence, (4) a guide on how to teach and assess for wise thinking, and, finally, (5) a synthesis to show how you can bring it all together in your classroom. In each chapter, you will find an overview of the concepts (e.g., successful intelligence, principles for sound assessment, wisdom), followed by concrete, hands-on examples of how *you* can implement these ideas in your classroom. Each part ends with a "your turn" space for you to reflect on and apply what you have just learned in that part. Yes, we will put you to work and ask you to respond to the book!

We hope that you will find this book to be a helpful and inspiring resource.

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PART I

Teaching for Wisdom, Intelligence, Creativity, and Success

1

Introduction to Teaching for Wisdom, Intelligence, Creativity, and Success

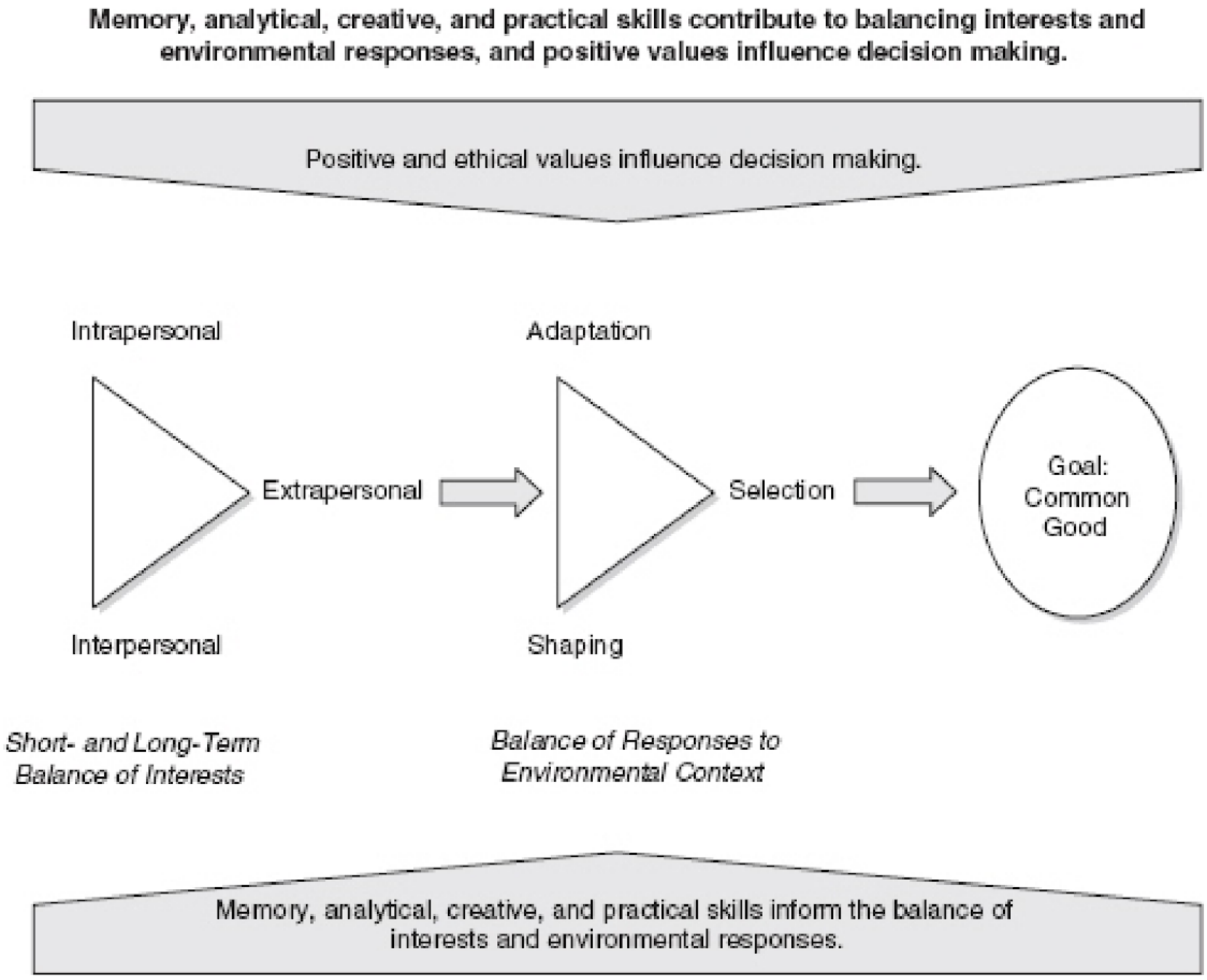
Part I briefly summarizes the theoretical model of human thinking and reasoning that we believe can provide insight into how students learn best. The theoretical model we refer to is known as "WICS" for *W*isdom, *I*ntelligence, and *C*reativity, *S*ynthesized. We believe that wisdom, intelligence, and creativity are key ingredients in a successful person's life, and that it is very important in educational settings to help students build on all these skills, in other words, to synthesize them. If you want to learn more about the theory behind the model, we have included an annotated bibliography of articles and books that describe the model more in detail in the Appendix to Part I at the end of this book. There, you will also find references to other authors who have investigated how students learn and offer strategies for teaching different skills such as analysis and creativity in the classroom.

Here we will just briefly review the WICS model, present some arguments for the importance of teaching for intelligence, creativity, and wisdom in the K–12 classroom, and finally, provide a brief self-evaluation scale for you, the reader, to determine your own profile of skills: Are your main strengths in memory, analytical, practical, or

creative abilities, or in some combination of them? A scoring key is provided in Answer Key toward the end of the book.

Figure 1.1 gives a visual overview of the WICS model.

Figure 1.1 The WICS Model of Thinking



2

What Is the WICS Model?

The purpose of this book is to serve as a hands-on guide to inspire you to broaden your teaching and assessment repertoire to ensure that all students in your classroom are as successful as they can be. The goal is not to offer you an Introductory Psychology or Intelligence 101 course, but to provide you with suggestions for dealing with some practical and real situations in the classroom.

Before we start, however, we quickly summarize the different theories of intelligence that are in vogue and describe the one we subscribe to, so that you know our position and so that we're all on the same page. In a nutshell, there are two kinds of theories of intelligence: (1) the singlefaceted, unified general intelligence (or *g*-factor) theories, which emphasize the nature of intelligence as a single entity; and (2) the multifaceted conceptions of intelligence, which emphasize the importance of multiple and distinctive aspects of intelligence.

Those who think that the first type of theory is correct generally view intelligence as relatively fixed and predetermined by genetic endowment, and as relatively independent from schooling. In other words, according to this theory, you are born with a certain amount of smarts, and the type of schooling you receive won't change it that much. The authors of this book, however, subscribe to the second of these two conceptions of intelligence. Many researchers who are familiar to teachers subscribe to this view, for example, Howard Gardner, the author of the theory of

Multiple Intelligences. Investigators in the second group generally agree that intelligence is the flexible capacity to learn from experience and to adapt to one's environment (using the skills required by and acquired through a specific cultural and social context). They also tend to agree that intelligence can be developed, whether through formal explicit instruction or in informal educational situations (depending on the types of abilities considered). The authors of this book believe that everyone has some initial abilities, and that these can be developed into competencies, and that these competencies can in turn be honed into expertise. We believe that these initial abilities depend in part on genetic heritage, but the manner and degree to which this genetic endowment is realized depends on the individual's environment. We believe that the key to success in the classroom—and in life more broadly—lies in a combination of intelligence, creativity, and wisdom, as per the WICS model.

We also believe there is an urgent need to teach to all abilities, and to match the assessment of achievement to such broad teaching. The time has come to capitalize on the variety of human resources because students' talents do not happen to correspond to the skills that schools traditionally have emphasized. Creative and practical abilities are certainly 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. The next parts of this book will provide you with more details on how to teach and assess for a broader range of abilities, and give you a wealth of concrete examples from classrooms at different grade levels and in different content areas.

Let's say that, so far, you agree with us that, in order to succeed in life, students need more than rote memorization and the ability to analyze. Let's say, also, that you think teachers should promote a broader range of skills in their classrooms to help more students of different abilities and learning profiles to succeed. At the same time, you may be asking yourself whether it's worth trying to implement all these changes and broaden your teaching repertoire. Teachers today are under a lot of

pressure and have many constraints related to seeing their students perform well on tests. Indeed, many teachers we have worked with over the years say that although they would like to include more creative activities in their classroom, for example, their school administration is not supportive and emphasizes only the importance of test scores. We all want to promote high achievement in our students, and we think that by broadening your teaching repertoire and addressing the needs of a wider range of students with different learning styles, you will do exactly that. You will help students—*all* students—achieve at higher levels. Teaching for creativity is not just a nice and fun add-on to the regular curriculum. On the contrary, it is a means to teach content, the content that our local, state, and federal standards and scope and sequence guidelines ask us to teach. In the Appendix to Part I at the end of this book, you'll find references to studies where we have actually measured whether or not this approach promotes learning (it does!), but for now, let's just list the four main reasons why the WICS model works for students and teachers.

REASON #1: APPRECIATION OF DIFFERENCES

To teach within the WICS model is to create a supportive learning environment in which students find their own ability patterns, understand how uniqueness allows each individual to make a particular contribution to the learning community, and value diversity. One step toward this goal is to *balance* the types of activities you offer your students so as to broaden the range of abilities addressed and give more students a chance to capitalize on their strengths (and compensate for their weaknesses). Part III of this book will give you some charts to help you achieve this balance in your classroom.

REASON #2: INCREASING RETENTION OF THE MATERIALS LEARNED

When you teach students through analytical, creative, as well as practical

instruction, you enable students to encode information in three different ways (analytically, creatively, and practically), in addition to encoding it for memory. Multiple encodings of information can help improve learning. The portion of this book devoted to teaching for enhancing memory will tell you more about how our memory works.

REASON #3: BUILDING ON STRENGTHS

In a classroom where only one type of skill is addressed (memorization, for example), only one type of learner, memory learners, will feel that they are able to use their strengths to be successful. Students who have strengths in other areas (creativity, for example) will never be able to let those strengths shine in the classroom. If, in contrast, you teach for a broad range of skills, you will give all students a chance to capitalize on their strengths and to compensate for, or correct, their weaknesses. In other words, there should be at least some instruction that is compatible with almost all students' strengths, enabling students to bring these strengths to bear on the work at hand. Instruction that enables students to capitalize on their strengths is also more likely to motivate students. At the same time, at least some of the instruction will probably not correspond to students' strengths. It is important also to encourage students to develop modes of compensation for and correction of weaknesses.

REASON #4: INCREASING STUDENT MOTIVATION

Instruction that balances different types of activities addressing different students' strengths (memory, analytical, creative, practical, and wise thinking skills) will be more motivating to students simply because it makes the material to be learned more interesting. Indeed, when we ask students whose teachers apply the WICS model about their engagement in the curriculum material, we find WICS-based instruction to be effective in capturing the students' interest. And, we all know that school today competes with a variety of different environmental stimulants and

capturing attention of students is difficult, so having a pedagogy that appears to be able to do so is really important for the overall success of schooling.

3

Your Turn

What Is Your Pattern of Strengths?

Now that we have reviewed the different types of abilities the WICS model focuses on, let's explore your own pattern of strengths, imagining that you are a student. Below, you will find a series of questions about your preferred assessments. This is not a scientific "test"; it's just one way to start thinking about your own preferred mode(s) of thinking, so that you can keep it in mind when you read the rest of the book and consider your students' varying patterns of strengths. We are intentionally putting you in a student's shoes, because typically students are not asked any of these questions because they are not usually given choices similar to those presented below. But, if you find yourself having preferences, so might they! Ready? Let's go! When you are finished, look at the answer key on page 13.

For each of the questions below, rate on a scale from 1 (low) to 5 (high) how much you would enjoy being evaluated via each type of assessment. You can use the same rating (1–5) several times for a give question. We're interested in your preferences, not in how easy each assessment would be. For example, it might be quicker to answer multiple-choice questions, but you would really more enjoy doing a project. For all these questions, please assume that you have studied the topics and know something about them, even if in reality you don't know

anything about soccer and wouldn't know how to compare it to football.

---

1. You just studied a lesson on the history of the Civil War.

I'd like to be evaluated with a(n)	*Your rating (1–5)*
a. multiple-choice test	
b. essay test asking me to compare the Civil War to the American Revolution	
c. test asking me to create an imaginary soldier and then write a fictionalized story that is nevertheless true to the details of the war, describing the soldier's life during the course of the war	
d. essay question asking me what lessons the Civil War holds for resolving the polarization between liberals and conservatives in contemporary American society	

2. You have just learned how to compute areas of different types of polygons.

I'd like to be evaluated with a(n)	*Your rating (1–5)*
a. test where I describe from memory how to compute the areas of each of the types of polygons	
b. test containing mathematical word problems that involve my computing areas of polygons in the context of solving the problems	
c. test where I have to write the mathematical word problems involving computing areas of polygons	

d. test where I compute the approximate area of the town in which I live, given a to-scale map	

3. You have just read the novel *Tom Sawyer*.

I'd like to be evaluated with a(n)	*Your rating (1–5)*
a. multiple-choice test requiring me to remember people and events from the book.	
b. test asking me to analyze how Tom Sawyer and Huck Finn are similar and different as people	
c. prompt to write a short story about what happened to Tom Sawyer and Becky Thatcher ten years later	
d. prompt to write an analysis of lessons about persuasion and salesmanship to be learned from Tom Sawyer's convincing his friends to whitewash Aunt Polly's fence	

4. You have just studied a biological-science lesson on the functioning of the major organs of the human body.

I'd like to be evaluated with a(n)	*Your rating (1–5)*
a. fill-in-the-blanks test assessing my mastery of the different functions of the major organs	
b. essay on how the functioning of the brain can affect the functioning of the heart	
c. assessment involving designing an experiment to see how different stressors affect the functioning of the heart	
d. essay on how smoking damages the	

functioning of the lungs	

5. You have just studied the geography of the Alps mountain range.

I'd like to be evaluated with a(n)	*Your rating (1–5)*
a. multiple-choice test assessing my knowledge of the geography of the Alps	
b. assessment asking me to compare the geography of the Alps to that of the Andes	
c. written task involving writing a story about the geography of a mountain range on an imaginary planet	
d. essay showing how the geography of the Alps has helped to promote alpine tourism	

6. In Spanish class, you have just learned words for many different kinds of foods.

I'd like to be evaluated with a(n)	*Your rating (1–5)*
a. fill-in-the-blanks test assessing my recall of the Spanish equivalents of the English words for ten different kinds of foods	
b. prompt to write an essay showing how the Spanish and English words for different kinds of foods are similar and different, and what generalizations can be drawn from these similarities and differences	
c. task involving creating an imaginary dialogue between an American diner and a Spanish waiter, where the American orders food in Spanish	

d. prompt to write an essay in Spanish on the healthiness of several different kinds of foods served in restaurants	

7. In art class, you have just studied principles of perspective in drawing and painting.

I'd like to be evaluated with a(n)	*Your rating (1–5)*
a. fill-in-the-blanks test assessing my memory for the principles	
b. assessment asking me to compare the use of perspective by two painters, Bosch and Bruegel	
c. task requiring the drawing of a scene in a park using the principles of perspective I learned	
d. demonstration of how principles of perspective are applied in a modern building in the town in which I live	

8. In music class, you have studied some principles of harmony.

I'd like to be evaluated with a	*Your rating (1–5)*
a. multiple-choice test on the principles of harmony	
b. prompt to compare the use of principles of harmony by Beethoven versus Copeland	
c. task to compose a tune in which I use principles of harmony	
d. prompt asking me to demonstrate how principles of harmony are used in contemporary advertising jingles to make	

products appealing to consumers	

9. In physical education, you have learned the rules of soccer.

I'd like to be evaluated with a(n)	*Your rating (1–5)*
a. fill-in-the-blanks test on the rules of soccer	
b. prompt to compare and contrast the rules of American football with soccer	
c. prompt to create my own game that is a combination of American football and soccer	
d. assessment asking me to demonstrate how violations of soccer rules were responsible for the defeat of a particular team in a recent World Cup match	

10. In general, to what extent do you prefer each of the following?

I'd like to be evaluated with a(n)	*Your rating (1–5)*
a. multiple-choice tests assessing my memory of material I have learned	
b. analytical essay test that requires me to analyze, compare and contrast, or evaluate things or ideas	
c. project where I have free reign for deciding how creatively to study a topic	
d. practical assessment that requires me to apply what I have learned to a real-world problem	

We hope you enjoyed completing the survey!

To score, add up the numbers you have written down for all the As, Bs, Cs, and Ds. You can use the table below to do it:

Question number	*Rating for option A*	*Rating for option B*	*Rating for option C*	*Rating for option D*
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
Total				

What do these scores mean? The response items labeled A are memory-based; the Bs, analytically-based; the Cs, creatively-based; and the Ds, practically-based. Your relative scores should give you a sense of your preference for each of the kinds of activities. In other words, if you score higher on A than on C, it indicates that you prefer to complete assessments that draw mostly on your memory skills rather than to complete assessments that ask you to be creative.

Notice that, in this particular assessment, we are looking at your preferences, and not necessarily your skills, for the different kinds of

tasks you might confront.

Some of us have a clear preference for one type of activity or skill (always practical, for example), while some of us tend to like all types of activities and no clear preference stands out.

Are you surprised by your results, or are these results what you expected?

Now think about what implications this exercise can have for your classroom. Your students have both preferences and profiles of success that can be very different from yours. If you teach and assess only to one type of ability (the one you prefer, say), then students with different profiles of strengths and preferences will have very few opportunities to shine in your classroom.

In the rest of this book, we will discuss how you can make sure that you address the needs of a broad range of students in your classroom, while at the same time making sure that you develop wise thinking skills in your students as well.

PART II

Why and How to Teach for Successful Intelligence

4

Introduction to Teaching for Successful Intelligence

If you walk into a typical classroom, one thing you will notice right away is that students come in all sizes, shapes, and forms—they are all very different from one another. And once you start teaching them, you discover that it's not just their physical appearance, but also their ways of learning and engaging in the classroom that are different. Some students are more engaged when they get to participate in hands-on activities, such as in a science lab. Other students are happiest when left alone in a corner reading or writing. Some pupils do well orally in one-on-one interactions with you or with their peers, but if you ask them to express themselves in writing, they do poorly. Some pupils do well with numbers, others with graphs and schematic representations, while some others do better with words to make meaning of numerical concepts.

Different students (and different teachers!) learn in different ways. To help us think about different types of students, consider how they learn best. As part of this consideration, offer students activities that will allow them to capitalize on their strengths, as well as activities that will help them reinforce their skills in areas in which they are not as proficient. Four main sets of skills are particularly relevant to reaching all students: memory, analytical (or critical) thinking, creative thinking, and practical thinking. Let's illustrate with a classroom description:

Shayna is a fourth grader with very strong analytical skills: she can read a story and quickly analyze the plot, determining the key elements of the story. But when it comes to displaying creative skills and writing a story of her own, she has difficulty coming up with original ideas. Taylor, on the other hand, is very creative: his creative abilities are not limited to story writing; he also displays these creative skills in science, and is usually the first student in the class to come up with ideas for new experiments. Ana represents yet a different pattern of strengths. When, in mathematics, she is given an abstract fraction problem to solve (such as 1/6 x 3), she is lost; but, if the problem is put into a concrete context so that she can see the practical consequences (for example, by asking her to divide three candy bars equally among six friends), she can solve the problem. Her practical abilities also shine through in language arts projects (for example, when students are asked to search for information on a given topic and present it to the rest of the class).

Take a moment to think about your own classroom. Can you think of students with these different profiles of strengths? If you are not presently in a classroom, think about your friends, family members, or peers to complete this reflection. Try to think of a specific activity or assignment in which each one of these students shines.

A student in my class who displays good memory skills is_____.

S/he likes to

- ☐ memorize
- ☐ recall
- ☐ recite
- ☐ (*Think of your own example here*)

A student in my class who displays good analytical skills is_____.

S/he likes to

☐ compare & contrast
☐ analyze
☐ evaluate
☐ explain
☐ judge
☐ critique

☐ (*Think of your own example here*)

A student in my class who displays good creative skills is_____.

S/he likes to

☐ create
☐ design
☐ invent
☐ imagine
☐ suppose

☐ (*Think of your own example here*)

A student in my class who displays good practical skills is_____.

S/he likes to

☐ apply
☐ implement
☐ employ
☐ contextualize
☐ (*Think of your own example here*)

_____

_____

_____

_____

The next four chapters explain how *any* curriculum can be infused with the featured skill, and providing examples from existing curriculum units at the elementary, middle, and high school levels. All the sample activities have been implemented and tested in classrooms.

5

How to Enhance Memory Skills

To teach for successful intelligence is to address four types of different thinking skills: memory, analytical skills, creative skills, and practical skills. Let's review each one of them and see how they can be enhanced. We start with memory because if you have no information or skills to draw upon, there is nothing to analyze, create, or apply!

One essential skill that we all have and use every day is memory. And, as most of us have experienced, memory fluctuates; some days you feel like you have much stronger memory skills than other days. Moreover, some people seem to have more of it than others. In healthy people, memory is like a muscle. It can be enhanced by giving it a regular "workout." Before we describe some of the strategies that can help your students (and you) enhance your memory skills, let's first review very briefly what memory is.

The three key elements to memory are: (1) encoding information (e.g., "getting it into your head"), (2) storing the information, and (3) retrieving the information effectively when you need it again. These skills are essential to success in life, in general, and in school, in particular. The skills are also important for high performance on standardized tests. Without memory—without something in our head to reason about—the other types of skills (analytical, practical, creative) are meaningless. You need information to analyze, to apply, or to be creative about and take to the next step. As the ancient Greek philosopher Plato is quoted as saying

in the fourth century B.C., "All knowledge is but remembrance."

Since Plato, we've come a long way in understanding what the different components of memory are, and how we can enhance them. Research on memory continues to be a burgeoning field, both within psychology and in the new neuroscience disciplines. We will not go into much detail on this research here, but for those of you who are interested in learning more, you can consult a psychology textbook or one of the numerous books available on how to increase your memory. For now, we will just focus on the *encoding* and *retrieval* of information.

Encoding refers to the way in which the new information is placed into and then organized in memory. For example, it is more efficient to summarize information before putting it into memory, or to encode the same piece of information twice in two different ways, for example, by remembering a word and its corresponding image. Think of an everyday example: when you try to memorize a phone number, it is easier if you chunk it into groups of two or three digits, rather than remembering each single digit. Take your area code, for example. Do you think of it as a three-digit number or as three separate digits?

Retrieval refers to the way in which the information is sought and found in memory. It is how you find your way back to the mental "shelf" where you stored the information. It is easier to retrieve information that is interconnected with other information, so that there are several "clues" to retrieval.

How can we help students enhance their encoding of new information so that it is easier to retrieve? Research has shown that *multiple* and *diverse* encodings are preferable to a single encoding. Repetition is good! In terms of schooling, this means that it is better to give students several opportunities to study and review the same material. Ideally, the opportunities would be different in kind, to encourage diverse encodings. Another general rule is the "spacing effect." Reviews that are spaced out are better than reviews that are close together in time, despite what your students who cram the night before an exam might think. So, repetition is good but repetition with breaks in between is even better. Finally, the

use of memory techniques (so called "mnemonic devices") is beneficial. In the classroom, you should give students a chance to practice both encoding and retrieval of information with specific mnemonic techniques.

Now that we've briefly reviewed the research, let's look at an example and put you to the test!

1. Take a piece of paper and a stopwatch or a watch that shows seconds.
2. When you are ready, look at the following number for ten seconds; then close the book and try to write down the number you just saw on your paper. You should not start writing down the number until *after* you've closed the book.

11231302928527246060

3. OK, now compare the number you wrote down to the number above. How many digits did you remember? Chances are, you did not remember all twenty digits. Now refer to the Answer Key at the end of this book and we'll illustrate how memory techniques could have helped you remember more digits.

In the Appendix to Part II, you will find more information on some specific mnemonic techniques and strategies that you can use in your daily life, or teach students to use. You will also find examples of classroom activities designed to enhance students' memory skills.

6

How to Enhance Analytical Skills

Most teachers provide instruction and learning experiences that require students to think analytically. Analytical skills are also sometimes referred to as critical thinking skills. Teaching for successful intelligence incorporates many instructional features that teachers typically use. Our aim is not to tell you about something radically new as much as it is to help you find a balance and make sure that all thinking skills can be proportionally represented throughout the curriculum. It is likely that in your classroom, analytical thinking is emphasized over practical or creative thinking most of the time, and you will not find it too difficult to come up with examples of analytical activities for your students. Below we provide some examples for inspiration.

LANGUAGE ARTS

The following are language arts skills that are essentially analytical in nature.

- Compare and contrast characters, plots, settings, or word meanings.

  _____

  _____

  _____

- Sequence or organize sentences, paragraphs, or events in a

narrative.

- Differentiate fact from opinion or literary genres.

- Give an opinion of/evaluate a book, an idea, different reference sources, or your own work.

- Use context clues to infer the meaning of a new vocabulary word, or learn about a literary character.

- Identify cause and effect.

Many other instructional strategies require analytical thinking. For example, "word sorts" are commonly used to encourage students to identify and classify word patterns. In word sorts, students group together words that have the same spelling patterns, definitions, phonetic sounds, roots or affixes, and so forth. The word-sort concept can be extended to the study of literature; students can be asked to categorize

types of characters, plot structures, and other literary elements. Another instructional strategy often used to help students categorize information is the advanced organizer. Graphic organizers such as semantic maps, flow charts, or Venn diagrams require analytical thinking.

Tables 1 and 2 present more examples of analytical language arts activities: one in which students analyze sentences to find the missing word and then combine clues to find the solution to a problem, and one in which groups of students compare and contrast different points of view.

Table 1 Analytical Activity From an Elementary School Lesson on the Mystery Genre

ACTIVITY: Solve it!

Student Identifier _____ Date _____

_____

In this activity, you will discover the meanings of new words by solving a puzzle. Find a word in the box that matches each definition. Write the correct word next to its definition. Write one letter on a line. (Clues: The spaces tell you how many letters the word has.) Then write the numbered letters on the matching numbered lines at the bottom of the page. Your answer will tell you "Who solves the mystery?" You may use a dictionary to check your answers.

mysterious, clue, villain, case, sleuth, suspect, witness, red herring, suspense, solution, evidence

1. Someone who solves mysteries; a detective ____ ____ ____ ____ ____ ____
   1
2. A hint that helps you solve the mystery ____ ____ ____ ____
   2 3
3. An evil person; someone who commits a crime ____ ____ ____ ____ ____ ____ ____
   4
4. Difficult to understand; puzzling ____ ____ ____ ____ ____ ____ ____ ____ ____ ____
   5 6
5. Someone who sees something ____ ____ ____ ____ ____ ____ ____
   7
6. Excitement from uncertainty; anticipation ____ ____ ____ ____ ____ ____ ____ ____
   8
7. Someone people think committed the crime ____ ____ ____ ____ ____ ____ ____ ____
   9
8. A false clue; a clue that does not lead to the solution (two words)
   ____ ____ ____ ____ ____ ____ ____ ____ ____
   10
9. The mystery to be solved ____ ____ ____ ____
   11
10. The answer to a puzzle or mystery ____ ____ ____ ____ ____ ____ ____ ____
    12
11. The clues and pieces of information that lead to a clear solution
    ____ ____ ____ ____ ____ ____ ____ ____
    3

    Who solves the mystery?

    ____ ____ ____ ____ ____ ____ ____ ____ ____ ____ ____ ____
    10 3 1 8 2 6 12 4 9 7 11 5

Table 2 Analytical Activity From a High School Lesson Accompanying the Reading of H. G. Wells's *The Island of Dr. Moreau*

Group Activity (30 minutes):

Discuss the fight between the captain and Montgomery described in the opening chapter.

Divide the whole class into two teams. Within each team, make subgroups of three or four students. Ask one team to consider the captain's point of view, and the other team to take Montgomery's standpoint. Ask each subgroup to develop arguments showing that "their" side is right. Then have one representative from a "Captain group" and one representative from a "Montgomery group" come up and debate in front of the class. Repeat with all subgroups.

SCIENCE

The following are science skills that are essentially analytical in nature.

- Compare and contrast a concave and a convex lens, herbivores and carnivores, or temperatures expressed in degrees Fahrenheit vs. in degrees Celsius.

- Sequence or organize chemical elements, or different types of magnets.

- Interpret the results of an experiment or a phenomenon you observe in nature.

- Make and verify predictions.

- Critique the adequacy of a given experiment to test hypotheses or an author's interpretation of results.

- Identify cause and effect or different theoretical frameworks.

Many other instructional strategies require analytical thinking, such as making and verifying predictions or interpreting observational data. For example, a typical activity in an ecology unit might be to plant seeds and then measure how much the plant grows every two days, recording and interpreting the data. Representing these data graphically also requires analytical thinking.

Tables 3 and 4 present more examples of analytical science activities.

Table 3 Analytical Activity From an Elementary School Lesson on Properties of Materials

Activity:

- Distribute one set of the ten sorting objects (paper clip, aluminum foil, LEGO brick, plastic spoon or cap, index card, paper napkin, pencil, stick, band, and eraser) to each student pair. Ask students to sort the objects into groups that contain objects that are alike in some way. Give some examples: the spoon and the foil might be grouped because they are usually found in the kitchen; the foil and the index card might be grouped because they are both flat.
- While students are sorting, sort your own set of objects into five different groups according to their material type: metal (paper clip and aluminum), plastic (LEGO and spoon or cap), paper (card and napkin), wood (pencil and stick), and rubber (band and eraser).
- Allow five to ten minutes for sorting by student pairs. Students should describe their sorting method in their journals.

Objects in group: How they are alike:

- Gather students together and ask each pair to tell the class about one of their object groups. As they describe their groups, record on a class chart their method for sorting. Divide the chart into three areas, one for sorting by property, one for sorting by function (use), and one for sorting by material type (but do not label these columns yet). For example, if students make a group of objects that are all white, record the word "white" on the chart in the property area.

If no student pair describes a group that is sorted by material (e.g., these items are all wood), then display your five groups and ask

students to guess your sorting method. Record the five different material types on your class chart.

Table 4 Analytical Activity From a High School Physics Lesson on Atoms

Name:

Homework Sheet: Net Charges

The electrical charge of an atom depends on the balance between protons and electrons. Below you will find a description of four different collections of subatomic particles.

Find the net charge for each one of the subatomic particles:

Protons	*Neutrons*	*Electrons*	*Charge*
1	0	1	
1	4	2	
14	15	13	
11	3	12	

In the above example, you were given the number of protons, neutrons, and electrons and asked to find the net charge of each collection. Now you will be given the net charge, and your task is to make up a corresponding collection of subatomic particles.

Protons	*Neutrons*	*Electrons*	*Charge*
			−3
			+5
			0
			+6

MATHEMATICS

The following mathematics skills are essentially analytical in nature.

- Compare and contrast numbers greater and less than 2^2, or different solutions to a mathematical problem.

- Sequence or organize number patterns, or geometrical shapes.

- Identify and classify mathematical formulas or types of functions.

- Evaluate strategies for word problems or proofs.