

# *Blitzer*



Precalculus  
5e

# PRECALCULUS



**Robert Blitzer**  
*Miami Dade College*



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# A Brief Guide to **Getting the Most** from this Book

## 1

### Read the Book

Feature	Description	Benefit
Section-Opening Scenarios	Every section opens with a scenario presenting a unique application of algebra or trigonometry in your life outside the classroom.	Realizing that algebra and trigonometry are everywhere will help motivate your learning. (See page 154.)
Detailed Worked-Out Examples	Examples are clearly written and provide step-by-step solutions. No steps are omitted, and each step is thoroughly explained to the right of the mathematics.	The blue annotations will help you understand the solutions by providing the reason why every algebraic and trigonometric step is true. (See page 668.)
Applications Using Real-World Data	Interesting applications from nearly every discipline, supported by up-to-date real-world data, are included in every section.	Ever wondered how you'll use algebra and trigonometry? This feature will show you how algebra and trigonometry can solve real problems. (See page 197.)
Great Question!	NEW to this Edition. Answers to students' questions offer suggestions for problem solving, point out common errors to avoid, and provide informal hints and suggestions.	By seeing common mistakes, you'll be able to avoid them. This feature should help you not to feel anxious or threatened when asking questions in class. (See page 547.)
Explanatory Voice Balloons	Voice balloons help to demystify algebra and trigonometry. They translate mathematical language into plain English, clarify problem-solving procedures, and present alternative ways of understanding.	Does math ever look foreign to you? This feature often translates math into everyday English. (See page 130.)
Learning Objectives	Every section begins with a list of objectives. Each objective is restated in the margin where the objective is covered.	The objectives focus your reading by emphasizing what is most important and where to find it. (See page 585.)
Technology	The screens displayed in the technology boxes show how graphing utilities verify and visualize algebraic and trigonometric results.	Even if you are not using a graphing utility in the course, this feature will help you understand different approaches to problem solving. (See page 323.)

## 2

### Work the Problems

Feature	Description	Benefit
Check Point Examples	Each example is followed by a similar matched problem, called a Check Point, that offers you the opportunity to work a similar exercise. The answers to the Check Points are provided in the answer section.	You learn best by doing. You'll solidify your understanding of worked examples if you try a similar problem right away to be sure you understand what you've just read. (See page 689.)
Concept and Vocabulary Checks	NEW to this Edition. These short-answer questions, mainly fill-in-the-blank and true/false items, assess your understanding of the definitions and concepts presented in each section.	It is difficult to learn algebra and trigonometry without knowing their special language. These exercises test your understanding of the vocabulary and concepts. (See page 167.)
Extensive and Varied Exercise Sets	An abundant collection of exercises is included in an Exercise Set at the end of each section. Exercises are organized within several categories. Your instructor will usually provide guidance on which exercises to work. The exercises in the first category, Practice Exercises, follow the same order as the section's worked examples.	The parallel order of the Practice Exercises lets you refer to the worked examples and use them as models for solving these problems. (See page 674.)
Practice Plus Problems	This category of exercises contains more challenging problems that often require you to combine several skills or concepts.	It is important to dig in and develop your problem-solving skills. Practice Plus Exercises provide you with ample opportunity to do so. (See page 344.)
Preview Problems	Each Exercise Set concludes with three problems to help you prepare for the next section.	These exercises let you review previously covered material that you'll need to be successful for the forthcoming section. Some of these problems will get you thinking about concepts you'll soon encounter. (See page 612.)



### 3

## Review for Quizzes and Tests

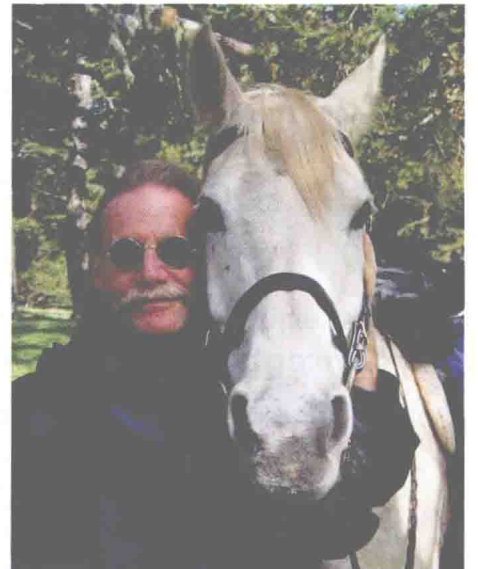
Feature	Description	Benefit
Mid-Chapter Check Points	At approximately the midway point in the chapter, an integrated set of review exercises allows you to review the skills and concepts you learned separately over several sections.	By combining exercises from the first half of the chapter, the Mid-Chapter Check Points give a comprehensive review before you move on to the material in the remainder of the chapter. <b>(See page 725.)</b>
Chapter Review Grids	Each chapter contains a review chart that summarizes the definitions and concepts in every section of the chapter. Examples that illustrate these key concepts are also referenced in the chart.	Review this chart and you'll know the most important material in the chapter! <b>(See page 764.)</b>
Chapter Review Exercises	A comprehensive collection of review exercises for each of the chapter's sections follows the grid.	Practice makes perfect. These exercises contain the most significant problems for each of the chapter's sections. <b>(See page 615.)</b>
Chapter Tests	Each chapter contains a practice test with approximately 25 problems that cover the important concepts in the chapter. Take the practice test, check your answers, and then watch the Chapter Test Prep Videos to see worked-out solutions for any exercises you miss.	You can use the chapter test to determine whether you have mastered the material covered in the chapter. <b>(See page 680.)</b>
Chapter Test Prep Videos	These videos contain worked-out solutions to every exercise in each chapter test and can be found in MyMathLab and on YouTube.	The videos let you review any exercises you miss on the chapter test.
Cumulative Review Exercises	Beginning with Chapter 2, each chapter concludes with a comprehensive collection of mixed cumulative review exercises. These exercises combine problems from previous chapters and the present chapter, providing an ongoing cumulative review.	Ever forget what you've learned? These exercises ensure that you are not forgetting anything as you move forward. <b>(See page 619.)</b>

# DEDICATION



## For Jerid (1985–2012)

And for those who have loved their pets  
and have been loved by them



# PREFACE

I've written *Precalculus, Fifth Edition*, to help diverse students, with different backgrounds and future goals, to succeed. The book has three fundamental goals:

1. To help students acquire a solid foundation in algebra and trigonometry, preparing them for other courses such as calculus, business calculus, and finite mathematics.
2. To show students how algebra and trigonometry can model and solve authentic real-world problems.
3. To enable students to develop problem-solving skills, while fostering critical thinking, within an interesting setting.

One major obstacle in the way of achieving these goals is the fact that very few students actually read their textbook. This has been a regular source of frustration for me and for my colleagues in the classroom. Anecdotal evidence gathered over years highlights two basic reasons that students do not take advantage of their textbook:

- “I’ll never use this information.”
- “I can’t follow the explanations.”

I’ve written every page of the Fifth Edition with the intent of eliminating these two objections. The ideas and tools I’ve used to do so are described for the student in “A Brief Guide to Getting the Most from This Book,” which appears at the front of the book.

## How Does *Precalculus* Differ from *Algebra and Trigonometry*?

*Precalculus* is not simply a condensed version of my *Algebra and Trigonometry* book. Precalculus students are different from algebra and trigonometry students, and this text reflects those differences. Here are a few examples:

- *Algebra and Trigonometry* devotes an entire chapter to linear equations, rational equations, quadratic equations, radical equations, linear inequalities, and developing models involving these equations and inequalities. *Precalculus* reviews these topics in three sections of the prerequisites chapter (P.7: Equations; P.8: Modeling with Equations; P.9: Linear Inequalities and Absolute Value Inequalities). Functions, the core of any precalculus course, are then introduced in Chapter 1.
  - *Precalculus* contains a section on constructing functions from verbal descriptions and formulas (1.10: Modeling

with Functions) that is not included in *Algebra and Trigonometry*. Modeling skills are applied to situations that students are likely to see in calculus when solving applied problems involving maximum or minimum values.

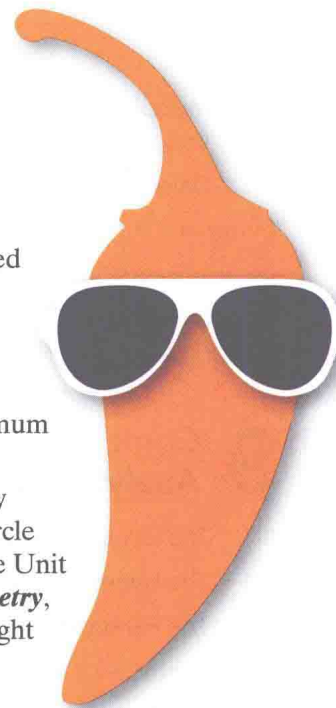
- *Precalculus* develops trigonometry from the perspective of the unit circle (4.2: Trigonometric Functions: The Unit Circle). In *Algebra and Trigonometry*, trigonometry is developed using right triangles.
- *Precalculus* contains a chapter (Chapter 11: Introduction to Calculus) that takes the student into calculus with discussions of limits, continuity, and derivatives. This chapter is not included in *Algebra and Trigonometry*.
- Many of the liberal arts applications in *Algebra and Trigonometry* are replaced by more scientific or higher level applications in *Precalculus*. Some examples:
  - Black Holes in Space (P.2: Exponents and Scientific Notation)
  - Average Velocity (1.5: More on Slope)
  - Newton’s Law of Cooling (3.5: Exponential Growth and Decay; Modeling Data)
  - Modeling Involving Mixtures and Uniform Motion (7.1: Systems of Linear Equations in Two Variables)

## What’s New in the Fifth Edition?

**New Applications and Real-World Data.** I’m on a constant search for data that can be used to illustrate unique mathematical applications. I researched hundreds of books, magazines, newspapers, almanacs, and online sites to prepare the Fifth Edition. Among the 108 worked-out examples and exercises based on new data sets, you’ll find applications involving modeling blood-alcohol concentration (Section P.1), starting salaries for college graduates (Section P.8), the world’s vanishing tiger population (Section 2.3), and the year humans become immortal (Section 3.1).

**Concept and Vocabulary Checks.** The Fifth Edition contains 679 new short-answer exercises, mainly fill-in-the-blank and true/false items, that assess students’ understanding of the definitions and concepts presented in each section. The Concept and Vocabulary Checks appear as separate features preceding the Exercise Sets.

**Great Question!** This feature takes the content of each Study Tip in the Fourth Edition and presents it in the





context of a student question. Answers to questions offer suggestions for problem solving, point out common errors to avoid, and provide informal hints and suggestions. ‘Great Question!’ should draw students’ attention and curiosity more than the ‘Study Tips.’ As a secondary benefit, this new feature should help students not to feel anxious or threatened when asking questions in class.

#### **New Chapter-Opening and Section-Opening Scenarios.**

Every chapter and every section open with a scenario based on an application, many of which are unique to the Fifth Edition. These scenarios are revisited in the course of the chapter or section in one of the book’s new examples, exercises, or discussions. The often humorous tone of these openers is intended to help fearful and reluctant students overcome their negative perceptions about math.

**New Blitzer Bonuses.** The Fifth Edition contains a variety of new but optional enrichment essays. Examples include “Using Algebra to Measure Blood-Alcohol Concentration” (Section P.1), “Seven Ways to Spend \$1 Trillion” (Section P.2), “Addressing Stress Parabolically” (Section 2.2), “Five Things Scientists Learned from the Hubble Space Telescope” (Section 9.3), and “Ponzi Schemes and Geometric Sequences” (Section 10.3).

**Sample Homework Assignments.** Within each Exercise Set, I have chosen odd-numbered problems, primarily from the Practice Exercises, that can serve as sample homework assignments. These are indicated by a blue underline in the Annotated Instructor’s Edition. Based on the goals and objectives of your course, you may wish to enrich each sample homework assignment with additional exercises from the other categories in the Exercise Set.

**New Interactive Figures.** These new figures bring mathematical concepts to life and are included in MyMathLab. Used as a lecture tool, the figures help engage students more fully and save the time spent drawing figures by hand. Questions pertaining to each figure are assignable in MyMathLab and reinforce active learning and critical thinking. Each figure has an accompanying Exploratory Exercise that encourages further study and can be used as a presentation tool or as an open-ended learning assignment.

### **What Content and Organizational Changes Have Been Made to the Fifth Edition?**

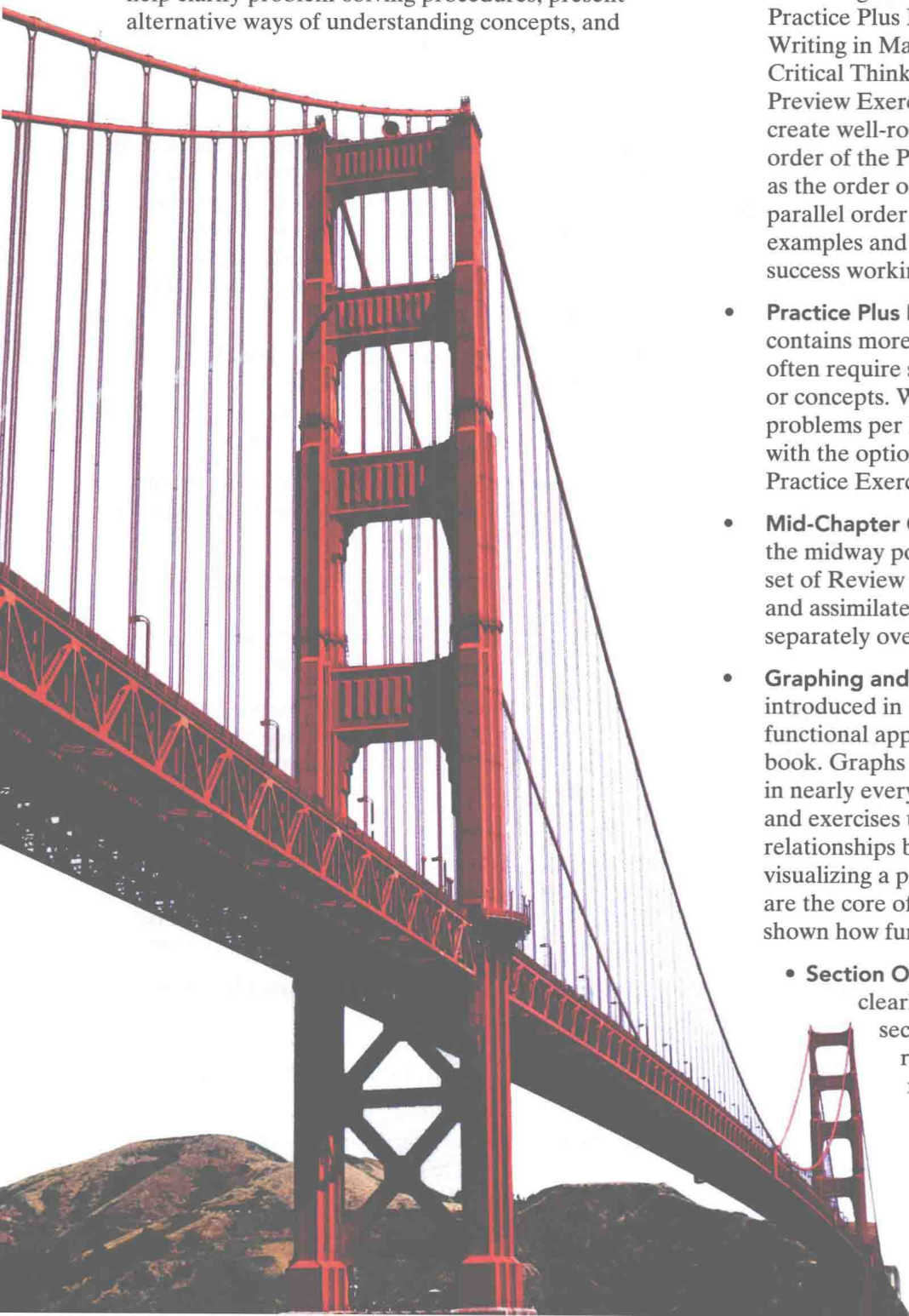
- **Section P.1 (Algebraic Expressions, Mathematical Models, and Real Numbers)** contains a new essay, now called a Blitzer Bonus, on using algebra to measure blood-alcohol concentration. This Blitzer Bonus should set the stage for the book’s engaging collection of unique applications.
- **Section P.6 (Rational Expressions)** presents a new example on excluding numbers from a rational expression with a trinomial denominator.
- **Section 1.6 (Transformations of Functions)** has a more thoroughly developed discussion of how stretching or shrinking changes a graph’s shape.
- **Section 1.7 (Combinations of Functions; Composite Functions)** has a new example on finding the domain of a function with a square root in the denominator. There is also a new example that ties in with the section opener (number of births and deaths in the United States) and illustrates an application of the algebra of functions.
- **Section 2.3 (Polynomial Functions and Their Graphs)** contains a new example on graphing  $f(x) = -2(x - 1)^2(x + 2)$ , a polynomial function whose equation is given in factored form.
- **Section 2.6 (Rational Functions and Their Graphs)** has a variety of exercises where students must factor to find vertical asymptotes or holes.
- **Section 2.7 (Polynomial and Rational Inequalities)** contains a new example on solving a polynomial inequality with irrational boundary points that requires the use of the quadratic formula.
- **Section 3.1 (Exponential Functions)** presents an intriguing new Blitzer Bonus on the year humans become immortal. The section also contains a new table clarifying interest plans in which interest is paid more than once a year.
- **Section 3.4 (Exponential and Logarithmic Equations)** has a new discussion (within the context of the Great Question! feature) on whether a negative number can belong to the solution set of a logarithmic equation.
- **Section 5.1 (Verifying Trigonometric Identities)** has a new discussion (within the context of the Great Question! feature) on the difference between solving a conditional equation and verifying that an equation is an identity.
- **Section 7.3 (Partial Fractions)** uses the Great Question! feature to include a discussion on speeding up the process of finding partial fraction decompositions.





## What Familiar Features Have Been Retained in the Fifth Edition?

- **Detailed Worked-Out Examples.** Each worked example is titled, making clear the purpose of the example. Examples are clearly written and provide students with detailed step-by-step solutions. No steps are omitted and key steps are thoroughly explained to the right of the mathematics.
- **Explanatory Voice Balloons.** Voice balloons are used in a variety of ways to demystify mathematics. They translate mathematical ideas into everyday English, help clarify problem-solving procedures, present alternative ways of understanding concepts, and connect problem solving to concepts students have already learned.
- **Check Point Examples.** Each example is followed by a similar matched problem, called a Check Point, offering students the opportunity to test their understanding of the example by working a similar exercise. The answers to the Check Points are provided in the answer section.
- **Extensive and Varied Exercise Sets.** An abundant collection of exercises is included in an Exercise Set at the end of each section. Exercises are organized within eight category types: Practice Exercises, Practice Plus Exercises, Application Exercises, Writing in Mathematics, Technology Exercises, Critical Thinking Exercises, Group Exercises, and Preview Exercises. This format makes it easy to create well-rounded homework assignments. The order of the Practice Exercises is exactly the same as the order of the section's worked examples. This parallel order enables students to refer to the titled examples and their detailed explanations to achieve success working the Practice Exercises.
- **Practice Plus Problems.** This category of exercises contains more challenging practice problems that often require students to combine several skills or concepts. With an average of ten Practice Plus problems per Exercise Set, instructors are provided with the option of creating assignments that take Practice Exercises to a more challenging level.
- **Mid-Chapter Check Points.** At approximately the midway point in each chapter, an integrated set of Review Exercises allows students to review and assimilate the skills and concepts they learned separately over several sections.
- **Graphing and Functions.** Graphing and functions are introduced in Chapter 1, with an integrated graphing functional approach emphasized throughout the book. Graphs and functions that model data appear in nearly every section and Exercise Set. Examples and exercises use graphs of functions to explore relationships between data and to provide ways of visualizing a problem's solution. Because functions are the core of this course, students are repeatedly shown how functions relate to equations and graphs.
- **Section Objectives.** Learning objectives are clearly stated at the beginning of each section. These objectives help students recognize and focus on the section's most important ideas. The objectives are restated in the margin at their point of use.



- **Integration of Technology Using Graphic and Numerical Approaches to Problems.** Side-by-side features in the Technology boxes connect a problem's solution to graphic and numerical approaches to solving that problem. Although the use of graphing utilities is optional, students can use the explanatory voice balloons to understand different approaches to problems even if they are not using a graphing utility in the course.
- **Chapter Summaries.** Each chapter contains a review chart that summarizes the definitions and concepts in every section of the chapter. Examples that illustrate these key concepts are also referenced in the chart.
- **End-of-Chapter Materials.** A comprehensive collection of Review Exercises for each of the chapter's sections follows the Summary. This is followed by a Chapter Test that enables students to test their understanding of the material covered in

the chapter. Beginning with Chapter 2, each chapter concludes with a comprehensive collection of mixed Cumulative Review Exercises.

- **Discovery.** Discovery boxes, found throughout the text, encourage students to further explore algebraic and trigonometric concepts. These explorations are optional and their omission does not interfere with the continuity of the topic at hand.

I hope that my passion for teaching, as well as my respect for the diversity of students I have taught and learned from over the years, is apparent throughout this new edition. By connecting algebra and trigonometry to the whole spectrum of learning, it is my intent to show students that their world is profoundly mathematical, and indeed,  $\pi$  is in the sky.

*Robert Blitzer*



## Acknowledgments

An enormous benefit of authoring a successful series is the broad-based feedback I receive from the students, dedicated users, and reviewers. Every change to this edition is the result of their thoughtful comments and suggestions. I would like to express my appreciation to all the reviewers, whose collective insights form the backbone of this revision. In particular, I would like to thank the following people for reviewing *College Algebra*, *Algebra and Trigonometry*, *Precalculus*, and *Trigonometry*.

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I would like to thank my editors at Pearson, Katie O'Connor and Dawn Murrin, who, with the assistance of Joseph Colella, guided and coordinated the book from manuscript through production. Thanks to Beth Paquin for the beautiful covers and interior design. Finally, thanks to Peggy Lucas for her innovative marketing efforts and to the entire Pearson sales force for their confidence and enthusiasm about the book.

*Robert Blitzer*



# DYNAMIC RESOURCES

## MyMathLab® Online Course (access code required)

MyMathLab delivers **proven results** in helping individual students succeed. It provides **engaging experiences** that personalize, stimulate, and measure learning for each student. And it comes from a **trusted partner** with educational expertise and an eye on the future.

To learn more about how MyMathLab combines proven learning applications with powerful assessment, visit [www.mymathlab.com](http://www.mymathlab.com) or contact your Pearson representative.

In Blitzer's **MyMathLab®** course, you have access to the most cutting-edge, innovative study solutions proven to increase student success. Noteworthy features include the following:

### Ready to Go Courses.

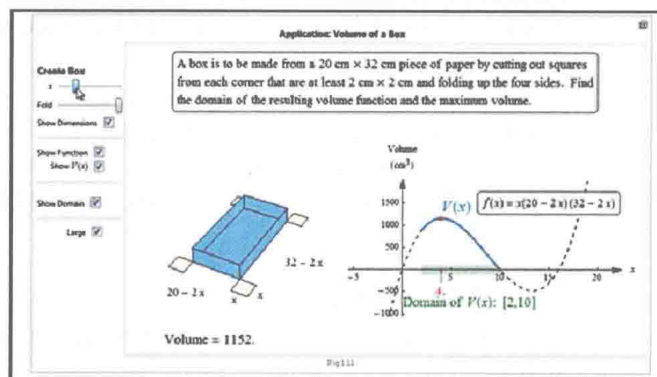
These new courses provide students with all the same great MyMathLab features that you're used to but make it easier for instructors to get started. Each course includes author-chosen, preassigned homework, integrated review questions, quizzes, and cumulative review exercises to make creating your course even simpler.

### Interactive Figures.

These *Mathematica*-based figures make the figures from the text come alive. Used during a lecture, interactive figures engage students more fully and save time that would otherwise be spent drawing them by hand. Exercises pertaining to each interactive figure are assignable in MyMathLab to reinforce active learning, critical thinking, and conceptual reasoning.

### Integrated Review.

Skill review quizzes are assignable throughout the course, testing students on prerequisite knowledge. From these quizzes, each student receives a personalized, just-in-time review assignment, allowing them to refresh forgotten concepts.



### MathTalk Videos.

Engaging videos connect mathematics to real-life events and interesting applications. These fun, instructional videos show students that math is relevant to their daily lives and are assignable in MyMathLab.

### Video Assessment.

Assignable MXL exercises are available for MathTalk videos to help students retain valuable information presented in the videos.

### Section-Lecture Videos.

These videos provide lectures for each section of the text to help students review important concepts and procedures 24/7.

### Concept and Vocabulary Check.

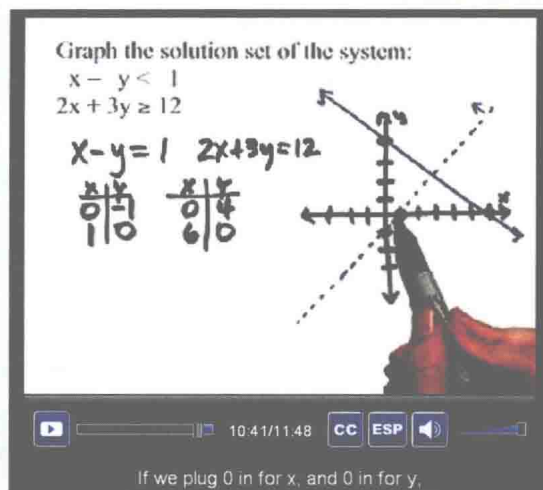
New and assignable in MyMathLab, these short-answer and fill-in-the-blank exercises provide a quick check for understanding of concepts. These questions also test for reading comprehension before the student moves on to the exercises.



[www.youtube.com/BlitzerPrecalculus5e](http://www.youtube.com/BlitzerPrecalculus5e)

### Chapter Test Prep Videos.

Students can watch instructors work through step-by-step solutions to all the Chapter Test exercises from the textbook. These are available in MyMathLab and on YouTube.



## Instructor Resources

Additional resources can be downloaded from [www.pearsonhighered.com](http://www.pearsonhighered.com) or hardcopy resources can be ordered from your sales representative.

### TestGen.

Enables instructors to build, edit, print, and administer tests using a computerized bank of algorithmic questions developed to cover all the objectives of the text.

### PowerPoint Lecture Slides.

Fully editable lecture slides that correlate to the textbook.

### Instructor's Solutions Manual.

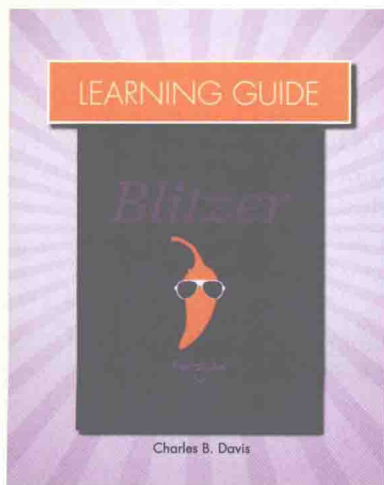
Fully worked solutions to all textbook exercises.

### Mini Lecture Notes.

Additional examples and helpful teaching tips for each section.

### Annotated Instructor's Edition.

Shorter answers are on the page beside the exercises. Longer answers are in the back of the text.



## Student Resources

Additional resources to help student success are available to be packaged with the Blitzer textbook and MyMathLab access code.

### Student's Solutions Manual.

Fully worked solutions to odd-numbered exercises and available to be packaged with the textbook.

### Learning Guide.

This note-taking guide is organized by objective and begins each chapter with an engaging application, providing additional examples and exercises for students to work through for greater conceptual understanding and mastery of mathematical topics. The Learning Guide is available as PDFs and customizable Word files in MyMathLab. They can also be packaged with the textbook and MyMathLab access code.



# TO THE STUDENT

The bar graph shows some of the qualities that students say make a great teacher. It was my goal to incorporate each of these qualities throughout the pages of this book.

## Explains Things Clearly

I understand that your primary purpose in reading *Precalculus* is to acquire a solid understanding of the required algebra and trigonometry topics in your precalculus course. In order to achieve this goal, I've carefully explained each topic. Important definitions and procedures are set off in boxes, and worked-out examples that present solutions in a step-by-step manner appear in every section. Each example is followed by a similar matched problem, called a Check Point, for you to try so that you can actively participate in the learning process as you read the book. (Answers to all Check Points appear in the back of the book.)

## Funny & Entertaining

Who says that a precalculus textbook can't be entertaining? From our quirky cover to the photos in the chapter and section openers, prepare to expect the unexpected. I hope some of the book's enrichment essays, called Blitzer Bonuses, will put a smile on your face from time to time.

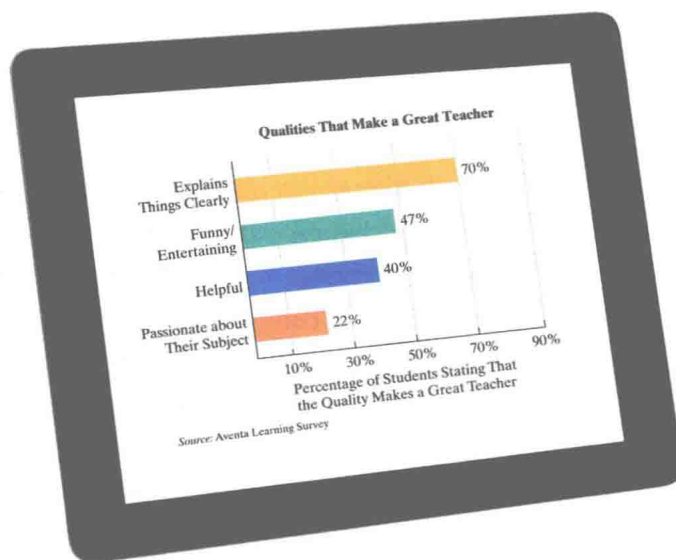
## Helpful

I designed the book's features to help you acquire knowledge of algebra and trigonometry, as well as to show you how algebra and trigonometry can solve authentic problems that apply to your life. These helpful features include

- **Explanatory Voice Balloons:** Voice balloons are used in a variety of ways to make math less intimidating. They translate algebraic and trigonometric language into everyday English, help clarify problem-solving procedures, present alternative ways of understanding concepts, and connect new concepts to concepts you have already learned.
- **Great Question!:** The book's Great Question! boxes are based on questions students ask in class. The answers to these questions give suggestions for problem solving, point out common errors to avoid, and provide informal hints and suggestions.
- **Chapter Summaries:** Each chapter contains a review chart that summarizes the definitions and concepts in every section of the chapter. Examples from the chapter that illustrate these key concepts are also referenced in the chart. Review these summaries and you'll know the most important material in the chapter!

## Passionate about the Subject

I passionately believe that no other discipline comes close to math in offering a more extensive set of tools for application and development of your mind. I wrote the book in Point Reyes National Seashore, 40 miles north of San Francisco. The park consists of 75,000 acres with miles of pristine surf-washed beaches, forested ridges, and bays bordered by white cliffs. It was my hope to convey the beauty and excitement of mathematics using nature's unspoiled beauty as a source of inspiration and creativity. Enjoy the pages that follow as you empower yourself with the algebra and trigonometry needed to succeed in college, your career, and your life.

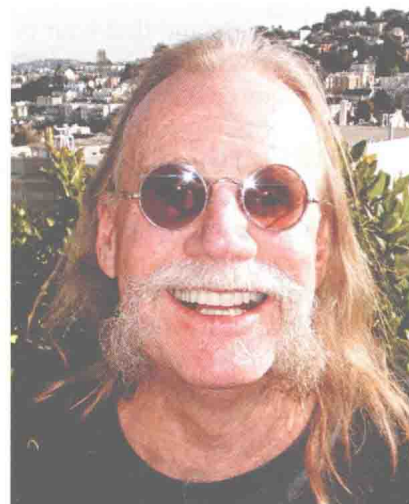


Regards,  
*Bob*  
Robert Blitzer



# ABOUT THE AUTHOR

**Bob Blitzer** is a native of Manhattan and received a Bachelor of Arts degree with dual majors in mathematics and psychology (minor: English literature) from the City College of New York. His unusual combination of academic interests led him toward a Master of Arts in mathematics from the University of Miami and a doctorate in behavioral sciences from Nova University. Bob's love for teaching mathematics was nourished for nearly 30 years at Miami Dade College, where he received numerous teaching awards, including Innovator of the Year from the League for Innovations in the Community College and an endowed chair based on excellence in the classroom. In addition to *Precalculus*, Bob has written textbooks covering introductory algebra, intermediate algebra, college algebra, algebra and trigonometry, trigonometry, and liberal arts mathematics, all published by Pearson. When not secluded in his Northern California writer's cabin, Bob can be found hiking the beaches and trails of Point Reyes National Seashore and tending to the chores required by his beloved entourage of horses, chickens, and irritable roosters.



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