

## BOOKS WITH PROBLEMS AND ACTIVITIES

**Alsina, C. & Nelsen, R.B. (2011).** *Charming proofs (A Journey into Elegant Mathematics)*. New York: Mathematical Association of America.

Abstract: Theorems and their proofs lie at the heart of mathematics. In speaking of the purely aesthetic qualities of theorems and proofs, G. H. Hardy wrote that in beautiful proofs 'there is a very high degree of unexpectedness, combined with inevitability and economy'. *Charming Proofs* presents a collection of remarkable proofs in elementary mathematics that are exceptionally elegant, full of ingenuity, and succinct. By means of a surprising argument or a powerful visual representation, the proofs in this collection will invite readers to enjoy the beauty of mathematics, and to develop the ability to create proofs themselves. The authors consider proofs from topics such as geometry, number theory, inequalities, plane tilings, origami and polyhedra. Secondary school and university teachers can use this book to introduce their students to mathematical elegance. More than 130 exercises for the reader (with solutions) are also included.

**Alsina, C. & Nelsen, R.B. (2006).** *Math made Visual (Creating Images for Understanding Mathematics)*. Washington, D.C: Mathematical Association of America, 2006.

Abstract: Is it possible to make mathematical drawings that help to understand mathematical idea, proofs and arguments? The authors of this book are convinced that the answer is yes and the objective of this book is to show how some visualization techniques may be employed to produce pictures that have both mathematical and pedagogical interest. Mathematical drawings related to proofs have been produced since antiquity in China, Arabia, Greece and India but only in the last thirty years has there been a growing interest in so-called "proofs without words." Hundreds of these have been published in "Mathematics Magazine" and "The College Mathematics Journal," as well as in other journals, books and on the Internet. Often times, a person encountering a "proof without words" may have the feeling that the pictures involved are the result of a serendipitous discovery or the consequence of an exceptional ingenuity on the part of the picture's creator. In this book the authors show that behind most of the pictures "proving" mathematical relations are some well-understood methods. As the reader shall see, a given mathematical

idea or relation may have many different images that justify it, so that depending on the teaching level or the objectives for producing the pictures, one can choose the best alternative. The book is divided into three parts. Part I consists of twenty short chapters. Each one describes a method to visualize some mathematical idea (a proof, a concept, an operation,...) and several applications to concrete cases, explained in detail. At the end of each chapter there is a collection of challenges so the reader may practice the abilities acquired during the reading of the preceding sections. Part II presents some general pedagogical considerations concerning the development of visual thinking, practical approaches for making visualizations in the classroom and a discussion of the role that hands-on materials play in this process. Part III consists of hints or solutions to all challenges of Part I.

**Barbeau, E. & Taylor, P.J. (eds). (2009). *Challenging Mathematics in and Beyond the Classroom (The 16<sup>th</sup> ICMI Study)*. New York: Springer**

Abstract: The last two decades have seen significant innovation both in classroom teaching and in the public presentation of mathematics. Much of this has centered on the use of games, puzzles and investigations designed to capture interest, challenge the intellect and encourage a more robust understanding of mathematical ideas and processes. ICMI Study 16 was commissioned to review these developments and describe experiences around the globe in different contexts, systematize the area, examine the effectiveness of the use of challenges and set the stage for future study and development. A prestigious group of international researchers, with collective experience with national and international contests, classroom and general contests and in finding a place for mathematics in the public arena, contributed to this effort. The result, *Challenging Mathematics In and Beyond the Classroom*, deals with challenges for both gifted as regular students, and with building public interest in appreciation of mathematics.

**Barbeau, E. (2000).** *Mathematical Fallacies, Flaws and flimflam.* New York: Mathematical Association of America.

Abstract: Through hard experience mathematicians have learned to subject even the most 'evident' assertions to rigorous scrutiny, as intuition can often be misleading. This book collects and analyzes a mass of such errors, drawn from the work of students, textbooks, and the media, as well as from professional mathematicians themselves.

**Berinde, V. (2004).** *Exploring, Investigating and Discovering in Mathematics.* Basel, Switzerland: Birkhäuser.

Abstract: This book offers creative problem solving techniques designed to develop and inspire inventive skills in students. It presents an array of selected elementary themes from arithmetic, algebra, geometry, analysis and applied mathematics. Includes solutions to over 100 problems and hints for over 150 further problems and exercises.

**Case, A. (1996).** *Who tells the truth? (A collection of logical puzzles to make you think).* Hertfordshire, UK: Tarquin.

Abstract: All the characters in these puzzles make clear statements about themselves and others, but it is not clear whether or not they are telling the truth. The problem is to decide which person to believe. Also, there are some curious paradoxical pictures which raise questions to answer.

**Cipra, B. (1983).** *Mistakes... and how to find them before the teacher does... (A Calculus supplement).* Berlin, Germany: Birkhäuser.

Abstract: An unusual supplement to every calculus textbook, Mistakes and How to Find Them before the Teacher Does is popular with students and teachers alike. Teachers love the way it encourages students to truly think about mathematics rather than simply plugging numbers into equations to crank out answers, and students love the author's

straightforward, tongue-in-cheek style. The title of this light-hearted and amusing book might well have been "Going Gray in Elementary Calculus and How to Avoid it." Changing the metaphor, Barry has hit the nail on the finger in hundreds of fine examples. --Philip J. Davis, coauthor of *The Mathematical Experience*. "How I wish that something like this had been available when I was a student!" --Ralph P. Boas, former editor of *The American Mathematical Monthly*. Bonus: Solution to LeWitt Puzzle.

**Eiss, H.E. (1988). *Dictionary of mathematical games, puzzles and amusements*. New York: Greenwood.**

Abstract: Mathematical play has challenged and stimulated human ingenuity throughout recorded history. It has ranged from the common sorts of brain teasers such as mazes, arithmetic story problems, and simple geometric puzzles to sophisticated explorations of questions that still concern modern mathematical theorists. This new dictionary provides a tantalizing variety of paradoxes, games, problems, and puzzles that will appeal to mathematics enthusiasts at every level of proficiency. Eiss introduces his subject with an overview of the history of recreational mathematics and its relation to some theoretical questions that have occupied mathematicians for centuries. Dictionary entries include problems posed by particular thinkers as well as traditional puzzlers that have come down to us anonymously. Information on the origins and history of many of the activities is supplied, and thorough cross-referencing enables the reader to locate all puzzles, games, and amusements of a similar type. The bibliography suggest sources of further information.

**Erikson, M. (2009). *Aha! Solutions*. New York: Mathematical Association of America.**

Abstract: Every mathematician (beginner, amateur, and professional alike) thrills to find simple, elegant solutions to seemingly difficult problems. Such happy resolutions are called "aha! solutions," a phrase popularized by mathematics and science writer Martin Gardner. Aha! solutions are surprising, stunning, and scintillating: they reveal the beauty of mathematics.

This book is a collection of problems with aha! solutions. The problems are at the level of the college mathematics student, but there should be something of interest for the high school student, the teacher of mathematics, the "math fan," and anyone else who loves mathematical challenges.

This collection includes one hundred problems in the areas of arithmetic, geometry, algebra, calculus, probability, number theory, and combinatorics. The problems start out easy and generally get more difficult as you progress through the book. A few solutions require the use of a computer. An important feature of the book is the bonus discussion of related mathematics that follows the solution of each problem. This material is there to entertain and inform you or point you to new questions. If you don't remember a mathematical definition or concept, there is a Toolkit in the back of the book that will help.

**Fomin D., Genkin S, Itenberg, I. (1996). *Mathematical Circles (Russian Experience)*. Providence, RI: American Mathematical Society.**

Abstract: "This is a sample of rich Russian mathematical culture written by professional mathematicians with great experience in working with high school students ... Problems are on very simple levels, but building to more complex and advanced work ... [contains] solutions to almost all problems; methodological notes for the teacher ... developed for a peculiarly Russian institution (the mathematical circle), but easily adapted to American teachers' needs, both inside and outside the classroom." --from the Translator's notes What kind of book is this? It is a book produced by a remarkable cultural circumstance in the former Soviet Union which fostered the creation of groups of students, teachers, and mathematicians called "mathematical circles". The work is predicated on the idea that studying mathematics can generate the same enthusiasm as playing a team sport--without necessarily being competitive. This book is intended for both students and teachers who love mathematics and want to study its various branches beyond the limits of school curriculum. It is also a book of mathematical recreations and, at the same time, a book containing vast theoretical and problem material in main areas of what authors consider to be "extracurricular

mathematics". The book is based on a unique experience gained by several generations of Russian educators and scholars.

**Fukagawa, H. & Rothman, T. (2008). *Sacred mathematics (Japanese Temple Geometry)*. Princeton, NJ: Princeton University Press.**

Abstract: Between the seventeenth and nineteenth centuries Japan was totally isolated from the West by imperial decree. During that time, a unique brand of homegrown mathematics flourished, one that was completely uninfluenced by developments in Western mathematics. People from all walks of life--samurai, farmers, and merchants--inscribed a wide variety of geometry problems on wooden tablets called *sangaku* and hung them in Buddhist temples and Shinto shrines throughout Japan. *Sacred Mathematics* is the first book published in the West to fully examine this tantalizing--and incredibly beautiful--mathematical tradition. Fukagawa Hidetoshi and Tony Rothman present for the first time in English excerpts from the travel diary of a nineteenth-century Japanese mathematician, Yamaguchi Kanzan, who journeyed on foot throughout Japan to collect temple geometry problems. The authors set this fascinating travel narrative--and almost everything else that is known about temple geometry--within the broader cultural and historical context of the period. They explain the sacred and devotional aspects of *sangaku*, and reveal how Japanese folk mathematicians discovered many well-known theorems independently of mathematicians in the West--and in some cases much earlier. The book is generously illustrated with photographs of the tablets and stunning artwork of the period. Then there are the geometry problems themselves, nearly two hundred of them, fully illustrated and ranging from the utterly simple to the virtually impossible. Solutions for most are provided. A unique book in every respect, *Sacred Mathematics* demonstrates how mathematical thinking can vary by culture yet transcend cultural and geographic boundaries.

**Guy, R.K. & Woodrow, R.E. (eds). (1994). *The lighter side of mathematics: Proceedings of the Eugène Strens Memorial Conference on Recreational Mathematics and its History*. New York: Mathematical Association of America.**

Abstract: In August of 1986 a special conference on recreational mathematics was held at the University of Calgary to celebrate the founding of the Strens Collection. Leading practitioners of recreational mathematics from around the world gathered in Calgary to share with each other the joy and spirit of play that is to be found in recreational mathematics. It would be difficult to find a better collection of wonderful articles on recreational mathematics by a more distinguished group of authors. If you are interested in tessellations, Escher, tilings, Rubik's cube, pentominoes, games, puzzles, the arbelos, Henry Dudeney, or change ringing, then this book is for you.

**Ivanov, O.A. (2005). *Making Mathematics Come to Life (A Guide for Teachers and Students)*. Providence, RI: American Mathematical Society.**

Abstract: "It is difficult to define the genre of the book. It is not a problem book, nor a textbook, nor a 'book for reading about mathematics'. It is most of all reminiscent of a good lecture course, from which a thoughtful student comes away with more than was actually spoken about in the lectures." -- from the Preface by A. S. Merkurjev If you are acquainted with mathematics at least to the extent of a standard high school curriculum and like it enough to want to learn more, and if, in addition, you are prepared to do some serious work, then you should start studying this book. An understanding of the material of the book requires neither a developed ability to reason abstractly nor skill in using the refined techniques of mathematical analysis. In each chapter elementary problems are considered, accompanied by theoretical material directly related to them. There are over 300 problems in the book, most of which are intended to be solved by the reader. In those places in the book where it is natural to introduce concepts outside the high school syllabus, the corresponding definitions are given with examples. And in order to bring out the meaning of such concepts clearly, appropriate (but not too many) theorems are proved concerning them. Unfortunately, what is sometimes studied at school under the name "mathematics" resembles real mathematics not any closer than a plucked flower gathering dust in a herbarium or pressed between the pages of a book resembles that same flower in the meadow besprinkled with dewdrops sparkling in the light of the rising sun.

**Joseph, G.G. (1991). *The crest of the Peacock (Non European Roots of Mathematics)*. London, UK: I.B. Tauris.**

Abstract: From the Ishango Bone of central Africa and the Inca *quipu* of South America to the dawn of modern mathematics, *The Crest of the Peacock* makes it clear that human beings everywhere have been capable of advanced and innovative mathematical thinking. George Gheverghese Joseph takes us on a breathtaking multicultural tour of the roots and shoots of non-European mathematics. He shows us the deep influence that the Egyptians and Babylonians had on the Greeks, the Arabs' major creative contributions, and the astounding range of successes of the great civilizations of India and China. The third edition emphasizes the dialogue between civilizations, and further explores how mathematical ideas were transmitted from East to West. The book's scope is now even wider, incorporating recent findings on the history of mathematics in China, India, and early Islamic civilizations as well as Egypt and Mesopotamia. With more detailed coverage of proto-mathematics and the origins of trigonometry and infinity in the East, *The Crest of the Peacock* further illuminates the global history of mathematics.

**Nelsen, R.B. (1993). *Proofs without words (Exercises in Visual thinking)*. New York: Mathematical Association of America.**

Abstract: Proofs without words are generally pictures or diagrams that help the reader see why a particular mathematical statement may be true, and how one could begin to go about proving it. Teachers will find that many of the proofs in this collection are well suited for classroom discussion and for helping students to think visually in mathematics.

**Nelsen, R. B. (2000). *Proofs without words II (More exercises in visual Thinking)*. New York: Mathematical Association of America.**

Abstract: This is a collection of pictures or diagrams that demonstrate why a particular mathematical statement may be true, and how one could begin to go about proving it. Teachers will find that many of the proofs in this collection are well suited for helping students to think visually in mathematics.

**Petkovic, M.S. (2009). *Famous puzzles of Great Mathematicians*. Providence, RI: American Mathematical Society.**

Abstract: This entertaining book presents a collection of 180 famous mathematical puzzles and intriguing elementary problems that great mathematicians have posed, discussed, and/or solved. The selected problems do not require advanced mathematics, making this book accessible to a variety of readers. Mathematical recreations offer a rich playground for both amateur and professional mathematicians. Believing that creative stimuli and aesthetic considerations are closely related, great mathematicians from ancient times to the present have always taken an interest in puzzles and diversions. The goal of this book is to show that famous mathematicians have all communicated brilliant ideas, methodological approaches, and absolute genius in mathematical thoughts by using recreational mathematics as a framework. Concise biographies of many mathematicians mentioned in the text are also included. The majority of the mathematical problems presented in this book originated in number theory, graph theory, optimization, and probability. Others are based on combinatorial and chess problems, while still others are geometrical and arithmetical puzzles. This book is intended to be both entertaining as well as an introduction to various intriguing mathematical topics and ideas. Certainly, many stories and famous puzzles can be very useful to prepare classroom lectures, to inspire and amuse students, and to instill affection for mathematics.

**Tao, T. (2006). *Solving Mathematical problems: A personal perspective*. New York: Oxford University Press.**

Abstract: Authored by a leading name in mathematics, this engaging and clearly presented text leads the reader through the various tactics involved in solving mathematical problems at the Mathematical Olympiad level. Covering number theory, algebra, analysis, Euclidean geometry, and analytic geometry, *Solving Mathematical Problems* includes numerous exercises and model solutions throughout. Assuming only a basic level of mathematics, the text is ideal for students of 14 years and above in pure mathematics.

**Zeeman, Sir C. (2005). *Three-dimensional theorems for schools*. Leicester, UK: The Mathematical Association.**

Abstract: It contains an eclectic mix of topics in three-dimensional geometry which Sir Christopher hopes will prove fascinating and stimulating to abler students in the later stages of secondary education. Topics include spherical triangles, concurrencies in a tetrahedron, perspective, cross-ratios, map projections, conics, knotting, linking and many more. Sir Christopher Zeeman was President of the Mathematical Association 2003 - 2004.