Book Review

Count Down

Reviewed by Daniel Ullman

Count Down
Steve Olson
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It is a modern American obsession to follow competitors in national championships. The much-heralded documentary film *Spellbound* follows eight children competing in the National Spelling Bee. The *New York Times* bestseller *Word Freak* examines the strange lives of competitive Scrabble players. American television coverage of the Olympics focuses more on the athletes ("Up close and personal!") than on the athletics. Witness also the current fascination with the popular television show *American Idol*, which pits aspiring young singers against each other in competition before caustic judges.

If you did not enjoy *Spellbound*, then you very likely would not enjoy the similarly titled *Count Down*, the story of the six American competitors in the 2001 International Mathematical Olympiad (IMO), held in the Washington, DC, area. The author, Steve Olson, has put together a thoughtful and engaging book, tackling with careful research and appropriate balance the many critical questions that naturally arise in any discussion of the IMO:

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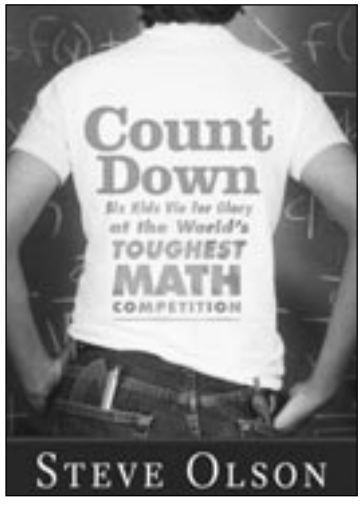

What makes these competitors different from other teenagers? Does intellect arise from nature or nurture? Is mathematical competition healthy? Why are there so few girls? And why so many Asian Americans representing the USA?

The author is not a mathematician, and the book is not written for mathematicians. In particular, mathematicians may feel frustrated at the author's rough sketches of the contestant's solutions to the IMO problems, which omit technical details necessary for a complete understanding. Nonetheless, the book successfully explains to a nonmathematical audience why mathematics is something that can be enjoyed. It succeeds also in conveying positive attitudes and dispelling negative stereotypes about mathematically talented people.

Olson has organized his book into six main chapters, each of which is devoted to one of the six team members, one of the six 2001 IMO problems, and one of what he sees as six critical attributes that these competitors display. A short interlude separates the first three of these chapters from the

last three, just as the IMO competitors get a night's rest between work on the first three IMO problems on the first day of the competition and the final three problems on the second. There are also a couple of chapters at the beginning of *Count Down* explaining how the IMO works and a couple of chapters at the end revealing how things turned out in 2001.

Attributes

The six attributes that Olson discusses are insight, competitiveness, talent, creativity, breadth, and a sense of wonder. In discussing these attributes, Olson is at his most successful. Each attribute is investigated in the context of a single competitor, a single 2001 IMO problem, and recent social science research.

In the chapter on insight—the word is to be understood in a literal sense: the ability to see images with the mind's eye—Olson notes the importance of visualization in mathematics. Indeed, mental imagery is a critical aspect of mathematical ability, and this may explain why many mathematicians are interested in music rather than visual arts: the development of the mind's eye reduces dependence on the visual eye. Olson reflects on the work of psychologists Roger Shepard, Beth Casey, and others, who argue that visualization is a special cognitive ability. Olson shows how this ability helped one participant solve the first 2001 IMO problem.

In the chapter on competitiveness, Olson takes on the writings of Alfie Kohn, the "great guru of anticompetitiveness", who argues that competition is a disease of our culture and is harmful to competitors. The IMO is a competition, and the participants find it immensely stressful. Is this healthy? Olson tackles this question head-on and shows how the competitiveness of one participant engaged him in mathematics and helped him solve the second 2001 IMO problem.

In the chapter on talent, Olson takes on the age-old and politically charged question of whether intellectual talent is innate or acquired. I find his treatment fair and balanced. In the end, he argues that the question hardly makes sense. "[G]enes are 100 percent responsible for our traits, and experiences are also 100 percent responsible for our traits." This is reminiscent of the question of whether light travels as particles or waves. My own view is that it is prudent to subscribe to the model that intellectual talent is acquired. We judge models not on the basis of their correctness per se but on the basis of their usefulness, their explanatory and predictive value. I choose to believe that students can learn, that studying pays off, that a student's potential cannot always be predicted, and that we have free will. I may be wrong about all this, but I am not sure that I can live comfortably in the world of the alternative. Moreover, I find in my experience much evidence supporting this model, and it allows me to understand many phenomena that I observe in the classroom.

Olson continues in three more chapters to introduce the three remaining participants, the three remaining 2001 IMO problems, and the attributes of creativity, breadth, and "a sense of wonder", by which he means, if I understand him, the aesthetic appreciation of mathematical beauty. In that chapter, Olson relates the already legendary story of Andrew Wiles's proof of Fermat's conjecture. This seems to digress from the theme of *Count Down*, although it is true that Wiles gave an inspiring keynote address at the closing ceremony of the 2001 IMO, and the gold medalists had the distinct and moving honor of receiving their medals at that ceremony (in the concert hall of the Kennedy Center of Performing Arts) from Wiles himself.

Problems

In *Count Down*, the IMO problems are reprinted verbatim, and their statements are explained. Even the students' solutions are discussed to a degree, with some details postponed to an appendix and some details suppressed entirely. Olson's judgement, it seems, is that complete solutions to the problems would have been over the heads of his audience. Reluctantly, I confess that I concur with his view. In not offering the details, though, he does not give his readers a full chance to appreciate mathematics. The best one can say is that he gives his readers a chance to appreciate the appreciation of mathematics. To Olson's credit, though, he does convey the impression that mathematical reasoning is just like any other kind of reasoning and that all people have the capacity to learn, understand, and enjoy mathematics. And even if details are missing, mathematical argument is by no means omitted. In fact, for most of his readers Olson will have engaged them in mathematical reasoning to a degree very likely exceeding any other reading they have ever done. Clearly Olson himself admires these young people and is moved by their beautiful and clever solutions to the IMO problems.

Mathletes

The six members of the USA 2001 IMO team were Tiankai Liu, Ian Le, David Shin, Oaz Nir, Reid Barton, and Gabriel Carroll, listed here in the order in which they appear in *Count Down*. Where do these talented youngsters come from? What kinds of families? Who are the mentors, the teachers? When was their talent first noticed? What other interests do they pursue?

In the six central chapters Olson introduces us to each of these young men, to their families, to their teachers, to their communities. His main message is that no stereotype appropriately captures these

kids. While I agree with him, it may be important to point out one feature that they do have in common: In each case, some mentor—perhaps a teacher, a parent, or a friend—recognized their extraordinary potential and provided them with a program outside of school to motivate their interest and develop their talent. "No child left behind" has a mirror image for gifted students: "No child prevented from going ahead". While we can applaud the weak student who keeps up, we should not applaud the gifted student being kept down.

I have observed that Olympiad team members tend to come from small families; they have fewer siblings on average. This supports the contention that the environment in which a student is living is as important as a student's native ability. It is hard to see how children with few siblings could have greater innate mathematical ability, but it is not hard to see how parents of a gifted only child may have the resources to provide the special environment that their child needs.

Interlude

An anecdote from the 1991 IMO in Sigtuna, Sweden. The participants faced this challenge:

Problem 6: Given any real number $a > 1$, construct a bounded infinite sequence $x_0, x_1, x_2, \ldots$ such that $|x_i - x_j||i - j|^a \geq 1$ for every pair of distinct i, j.

Lenny Ng, an American competitor (now a postdoc in mathematics at Stanford), provided a complicated construction accompanied by certain details suggesting that the construction worked. The written work encompassed a mere two pages, but the graders were stumped. Should this be regarded as an essentially correct solution or not? Should this get full credit, nearly full credit, or no credit at all? Did the construction even work? No one was quite certain. Eventually, the grading of the entire competition was complete and the scores were posted, except for this one problem from this one student. The graders convened a special session to examine Lenny's solution. A dozen mathematicians pondered the construction for several hours. A decision was finally rendered: Because complete details were not provided, Lenny would get only 3 out of 7 points for this solution.

I asked Lenny recently whether his solution to that problem had in fact been correct. Admitting that he did not recall the details, he responded: "I remember being convinced that the solution was correct. However, there was a crucial bit of handwaving involved that I hoped would be obviously true to the graders. It seemed true to me. Needless to say, it turned out not to be obvious at all, maybe not even true." So we still do not know.

I tell this story occasionally to nonmathematicians in order to convey the nature of the IMO: The IMO calls for sophisticated, subtle, high-level reasoning, of a type quite different from what is required to succeed at, say, the National Spelling Bee, where judging the correctness of a solution is a routine matter, requiring knowledge of the 26 letters of the alphabet and nothing more. The IMO promotes creativity and development of ideas rather than memorization and computation. In the end, spelling is just not that important. What is important is reasoning, inventiveness, and communication, precisely what the IMO promotes.

Motivation

The next generation of mathematicians will come from young people who possess both the talent and the inclination to do mathematics. We must pay attention to both elements. The mathematical precocity of the Olympiad competitors is something to behold, but more rare yet is their mathematical motivation. It is no miracle that seventh-graders who read number theory texts over summer vacation develop their mathematical abilities to a higher degree than their classmates. The miracle here is that such students find the motivation, the support, the rewards to engage in this kind of summer activity in the first place.

This is why we need the Olympiads. Mathematics competitions allow us to reward and celebrate mathematical talent in the same way that athletic competitions allow us to reward and celebrate athletic talent. Young people naturally want to excel and be recognized for their excellence. In our culture, this draws children toward athletics. To a lesser degree, it draws children toward music and theatre, where performance is inherent. But mathematical writing does not make a very good spectator sport, and we have a more difficult task when trying to acknowledge accomplishment in our discipline.

Gender

Four hundred seventy-three young people representing eighty-three countries participated in the 2001 IMO. Of these, 445 were boys and 28 were girls. The USA has competed in twenty-nine IMO's, starting in 1974. During that time a total of 127 young people have had the opportunity to represent our country at this event. Of these, 126 were boys and just 1, Melanie Wood, was a girl. (Melanie served as a coach for the 2001 IMO team from the U.S. and is a central character in *Count Down*. She is a recent winner of the Morgan Prize for undergraduate research and will be a doctoral student in mathematics at Princeton in the fall.) There is some irony in the fact that, while we in the U.S. regard ourselves as more progressive than many other countries in our beliefs about the equality of women, we have done a particularly poor job of promoting girls to the top ranks of mathematics competition.

Why is this? It is not an easy question to answer. Once upon a time, adults instructed children that mathematics was for boys and not for girls, and no one can be surprised that girls did not advance in mathematics in such a climate. To the extent that such attitudes persist, girls continue to face obstacles today. But most teachers nowadays are sensitive to the dangers of stereotyping; the message that math is not for girls is no longer so overt. Yet the Olympiad programs continue to be dominated by boys. Olson debunks several of the easy explanations, such as the one that links mathematical ability to the Y-chromosome. Unfortunately, this points the finger in a yet more unpleasant direction: our American culture. The power of culture over us is too strong to be overcome by public relations messages. We can and should tell students that girls can do math too, but on television the high school student who is good in math is a boy geek; the girls do not emulate him or even date him. We can and should develop programs to advance girls in mathematics, but when Barbie says, "Math is hard!" the battle may be lost. We can and should show positive images of successful, female mathematicians, but when Mom tells her daughter that she can't help with homework ("Go ask your father"), a powerful message is communicated.

I remain optimistic that cultural signals encouraging girls to avoid mathematics will become less prevalent. Culture changes only slowly, though, and the time scale for these changes may be decades. Still, the past few decades give us reason for hope, and we may expect in a few more decades that Americans will come to see mathematicians as passionate and happy and engaging and female and male. In particular, the achievement of girls on the most recent USA Mathematical Olympiads has been stronger than ever before.

Mathematical Olympiads

Most Americans, of course, have no idea what the mathematical enterprise is about. They have no idea either what sort of problems would be on an international competition in mathematics. Those who equate mathematics with arithmetic probably imagine that Olympiad competitions involve addition of fantastically long columns of numbers, or perhaps races in mental multiplication. Or their image may be of Math Counts, the middle school national mathematics competition devised as our profession's answer to the telegenic National Spelling Bee. But Math Counts is to the IMO as spelling is to writing. Olympiads are contests of ideas.

The term "Mathematical Olympiad", as I use it, refers to a contest that requires participants—let's not be shy about it—to create and write mathematical proofs. Olympiads are not multiple-choice exams, they are not graded by machine, and the problems are not mere exercises to be solved in one routine step. Participants get plenty of time; it is not a race, but the problems are challenging. Not every schoolchild is prepared to handle an Olympiad, but many more ought to learn. In Russia, there is a network of regional and junior Mathematical Olympiads. I would like to see the development of a similar network in this country, where currently the national Olympiad (USAMO) is offered to only about 250 high school students each year. Because the grading of Olympiads is time intensive, the preliminary exams are best handled regionally. There is no reason not to begin with students in middle schools, although the questions need to be at an appropriate level. A network of Olympiads would help promote mathematics as a discipline of reasoning rather than computation. I propose a United States of America Junior Mathematical Olympiad (USAJMO), whose competitors would be top middle school performers from regional or state junior Olympiads. Some may say that Math Counts already does this, but Olympiads are fundamentally different and in my view place value on a more critical attribute: the ability to create, to reason, and to express results in a persuasive written essay.

Results

Olson's book concludes with the story of the 2001 IMO results. Who won and who lost? How did it turn out? I would like to conclude here with the story of how *Count Down* will fare. Will it sell? How will it turn out? I am not sure, but here is my prediction. There is less diversity among these six boys than there is among the eight competitors in *Spellbound*, so the IMO story may have somewhat less appeal on this ground. Far more Americans play Scrabble than solve Olympiad problems, so readers may relate less well to *Count Down* than they did to *Word Freak*. And far, far more Americans will enjoy *American Idol*, which features plenty of competitors devoid of talent to amuse its audience. Nonetheless, Steve Olson has provided a deeper and more meaningful investigation of precocity and talent than is found in these other works, and he can be credited with a fine and thoughtful book even if it does not appeal to millions. And should *Count Down* become a bestseller after all, it may help significantly to correct the misimpressions that many Americans have of mathematics.