MAKING THE IMO TEAM:

The Power of Early Identification and Encouragement

by Julian Stanley

For high school students in the United States, winning a medal in an International Mathematical Olympiad (IMO) is the pinnacle of success in mathematical competitions.* The six members of the U.S.'s IMO team each year, who in July spend two grueling days solving mathematical problems, usually in a foreign country, have been drawn from three or four hundred thousand applicants in successive contests. Those six are the cream of the U.S.A. Mathematical Olympiad. At the final stage, they were chosen from the 24 participants in a 3- to 4-week residential training session for the IMO.

In July of 1986 in Warsaw, the United States tied Russia for first place among the 37 nations competing. Three of its team members won silver medals, and three won gold medals. One (Joseph Keane) received the only special prize awarded to *any* IMO contestant that year. Only half of the IMO participants win even a bronze medal.

The six reside in New York City (2), California, Maryland, Michigan, and Pennsylvania. Four (William Cross, Jeremy Kahn, Keane, and John Overdeck) came from the approximately 250 members of the Johns Hopkins Study of Mathematically Precocious Youth (SMPY) "700-800 on Standard Achievement Test — Mathematics (SAT—M) Before Age 13" group still in high school during the 1985-86 academic year. Just one of the four was as old as the typical high school senior when the IMO was held. The other two members of the team came from the more than six million high school students who were eligible. How did these 48,000:1 odds arise?

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The Key to the Odds

The four SMPY prodigies had been identified at age 11 or 12 as having scored at least 700 on the mathematical part of the College Board Scholastic Aptitude Test (SAT—M). Only 6% of college-bound male *twelfth graders* score that well. By age 17 or 18 youths who reasoned that well mathematically before age 13 should score the equivalent of 900 or so on a test like SAT—M that has enough *ceiling* for them.

Quite likely, the other two members of the U.S. IMO team would have scored 700 or more on SAT—M before age 13, had they taken it then. SMPY estimates that about 400 boys and girls each year could reach that criterion, but in its limited searching SMPY was able to locate only about 100 of them each year for three years (November 1980 through October 1983).

Identifying early a set of young students who reason extremely well mathematically, telling them about their potential, providing special ways to learn mathematics fast and well, and repeatedly urging them to enter local, state, and national mathematics competitions seem to be the key to the odds stated above. Some reach the IMO quicker than others. For example, 1986 was Kahn's fourth consecutive year on the team. He had broken the record in 1983 by making the team at age 13. Probably as a 12th grader in 1987 he will compete for the fifth, and last, time.

It was Keane's second and last time, because he graduated from high school a month earlier. More of SMPY's "700-800 on Standard Achievement Test — Mathematics (SAT—M) Before Age 13" members are in the wings to fill the five vacancies on the team that high school graduation has caused. Of the 24 persons in the U.S. training session for the IMO in 1986, 12 are members of that group.

SMPY began its talent searches in 1972, although not at the 700M level. Its first participant in an IMO was Mark Pleszkoch, in 1979. Then Brian Hunt was on the team in 1981 and 1982 before graduating from high school at age 16 and earning his master's degree in mathematics at age 17. Thus, during the 8 year 1979-86 a total of 11 slots on the team have been filled by members of SMPY's 700-800M groups. Only in 1980 were they not represented.

* *For information about the process, contact the Mathematical Association of America, 1529 Eighteenth Street, N.W., Washington, DC 20036, telephone (202)387-5200.*

T⁴: Terry Tao, Tops at Ten

Another of SMPY's proteges in the 1986 IMO was Terence Tao of Australia. At age 8 he had scored 760 on SAT—M the first time he took that test, and a year later visited the United States with his parents to plan his education (Gross, 1986; Stanley, 1986a, b). On Australia's IMO team at age 10, he won a bronze medal. Australia ranked 15th among the 37 nations; no one else on its team won more than a bronze medal. Terry's parents deserve much of the credit for this remarkable accomplishment.

The Moral of This Tale

Early identification, educational facilitation, and encouragement seem highly effective in producing outstanding members of the U.S. team in the IMO. They are by no means sufficient, of course. Quite a few of the 292 superb mathematical reasoners SMPY found did not choose to try hard or repeatedly, if at all, in mathematics contests. Some made great efforts, but

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fell short of getting a berth on the team itself. After all, 6 is an extremely small number compared with the 300,000 or so who enter the initial contest each year. The IMO operates only via 6-person teams, whereas the college-level Putnam Competition allows each college to designate its three team members and encourages anyone else to try as an individual. Both approaches have their virtues and limitations.

Unlike its bad name in international surveys of knowledge of mathematics at the precollege level (Stevenson, Lee, & Stigler, 1986), the United States has done well in IMOs since first entering the competition in 1974. The nation's mathematically ablest students are as good as the best elsewhere in the world. Choosing the six IMO team members each year objectively in several elimination rounds gives our team the advantage of recency. In comparison, several communist countries tend to select promising prospects quite young and train them intensively for a number of years. In effect, they train not quite the best because of variation in development over time.

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Some will decry this form of competition as being a mishmash of *ad hoc* tricks of problem solving that do not add up to a good grasp of mathematics itself. Others (Kohn, 1986) would probably fault the IMO procedure for leaning too heavily on extrinsic rather than intrinsic motivation: getting on the team, winning a medal, or seeing one's name in the news. There is, however, much cooperation, especially in the training session, and a great deal of camaraderie with one's mathematics-competition peers from many nations. Virtually all of the team members are taking excellent college mathematics courses while still in high school, so they do learn the subject in its more noncompetitive aspects.

One should not overlook the other two National Olympiads, Chemistry and Physics. Two of the four members of the 1985 U.S. ICO team and one of its 1986 team had qualified for SMPY's "700-800 on Standard Achievement Test — Mathematics (SAT—M) Before Age 13." So had 2 persons who were on the first (1986) U.S. IPO team.*

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On balance, I believe that participating in competitions is a wholesome intellectual pursuit for youths who have the aptitude and motivation to do well in them.

* *For information about the International Chemistry Olympiad, contact the American Chemical Society, Education Department, 1155 Sixteenth Street, N.W., Washington, DC 20036, telephone (202) 872-4600, ext. 4590. For the International Physics Olympiad, contact the American Association of Physics Teachers, 5110 Roanoke Place, Suite 101, College Park, MD 20740, telephone (301)345-4200.*

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