# Academic Competitions Serve the U.S. National Interests

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## Abstract

Competitions are used by many teachers at the grass roots level to develop the talents of their gifted students. Each year the top Math, Chemistry, and Physics Olympiad students are identified and assembled into national teams that compete against teams from around the world. This article summarizes findings from the American Olympiad study. Our investigators analyzed data from 345 adult Olympians and found that 52% earned doctorates, and these individuals pursued careers in technical areas that benefit the nation. So far these Olympians have published 8,629 publications, and many of the Olympians have assumed positions in universities or research institutions that contribute to the productivity of the United States. Their success supports competitions as a viable alternative for developing the talents of the gifted.


Key Words: Cross-cultural, Academic Olympians, gifted, talent development, career development, competitions, motivation, parent involvement, adult productivity

## Introduction

This article places the Olympiad studies into the larger context of choosing competitions as one of the alternatives that can be used by educators to develop the talents of the gifted. The academic Olympiads were selected for study as representative of the many competitions that are held each year both in the United States and in other countries around the world. There are more than 100 competitions that are being used by teachers in the U.S. (Karnes & Riley, 1996, 2005). These competitions exist in numerous academic (10 general academics, 2 creative thinking and problem solving, 4 foreign languages, 50 language arts, 9 math, 23 science, 16 social studies, 4 geography, 5 technology) and nonacademic areas (38 fine and performing arts, 9 leadership, and 7 service competitions). The types of competition vary greatly by grade level and type. However, all of these competitions represent challenges to their participants. This article takes just one kind of outside school competition and analyzes its potential. From the results of this analysis, we draw inferences about the applications to other competitions.

At the elementary school level, Campbell (1998) found that the most widely used competitions are Future Problem Solving (www.fpsp.org) and Odyssey of the Mind (www.info@odysseyofthemind.com) (creative thinking and problem solving) programs. The two largest high school competitions are the National Merit Exam and International Science and Engineering Fairs (ISEF). Each involves more than a million participants. Both are national in scope. Campbell, Wagner, and Walberg (2000) found that 18% of United States high school students participate in various competitions each year.

## Assumptions Underlying Competitions

All competitions operate under a series of assumptions that constitute a distinctive rationale:

(1) Children with talent need to be identified early.

(2) Competitions are needed because many schools do not have the differentiated curriculum or the resources that are needed to challenge extraordinary students.

(3) Contests will attract participants with extraordinary talent.

(4) Contests will motivate the early development of talent.

(5) Once developed, this talent is expected to contribute to society.

In this article, discussion is provided about the veracity of each of these assumptions. The first assumption originated with Terman (1922, 1925) when he started his monumental longitudinal study of more than one thousand gifted students. The academic Olympics originators also made the same assumption (Kukushkin, 1996). More modern studies (Ericsson, Krampe, & Tesch-Romer, 1993) also find that early identification leads to enhanced performance.

The second assumption deserves some explanation. The competitions that have become national in scope have evolved to the point where the students that emerge as winners produce impressive products. Certainly the INTEL Science Talent Search showcase many advanced projects that originate at universities, research labs, and research hospitals (Campbell, 1985, 1988, 2002). To illustrate the complexity of these projects, we list two of the 2009 finalists' project titles. The first project was produced by Eric Shyu, and its title is "Luminescent Cadmium Coordination Polymers with Diverse Structural Morphologies Constructed from Dicarboxylate and 4,4'-Dipyridylamine Ligands." This advanced chemistry project illustrates sophisticated work and expertise beyond most high school students.

The author of second the project is Preya Shah, and the title is "Combating Cancer: Design and Synthesis of Dual-Warhead Tumor-Targeting Drug Conjugates." Cancer research is generally funded and requires advanced facilities and personnel to handle this type of work. (http://www.societyforscience.org/sts/68sts/semibook09.pdf).

These titles illustrate the complexity of the work being recognized by this competition. Few high schools in the United States are equipped to have the facilities or the expert personnel needed to conduct projects at this level of sophistication. Likewise, the academic Olympiad competitions that will be the focus of this article require advanced knowledge beyond the subject matter offered in most U.S. high schools. To illustrate, the syllabus of the International Chemistry Olympiad contains subject matter from several areas of chemistry, including organic chemistry, inorganic chemistry, physical chemistry, analytical chemistry, biochemistry, and spectroscopy. (http://en.wikipedia.org).

Assumption 3 proposes that the contests will attract participants with extraordinary talent. How do these individuals find out about the competitions that match their talent? Since the potential participants are students, there must be linkages with knowledgeable adults who know about the competition. Teachers and parents serve this purpose by learning the rules and deadlines and preparing the talented student for the rigors of the contest.

Assumption 4 assumes that the contests will motivate the early development of talent. When an individual's deep-seated interests and innate talents match the competition's challenges, intrinsic motivation is triggered. According to the Theory of Work Adjustment (Lubinski, Benbow & Morelick, 2000), there is a correspondence between each person's abilities and the abilities inherent in the work. When both converge, accomplishment is enhanced.

The last assumption is the most important because it encompasses the value of competitions as an alternative for developing the talents of the gifted. If competitions are successful, their participants should make contributions to society.

How is it possible to learn about such contributions? The only way to uncover these facts is to locate former participants and discover what, if anything, they have accomplished.

In selecting a competition to investigate, four criteria were used: the competition must be international; the principal investigators must have no contact with the sponsors of the competition; the competition must have a small number of winners; the competition must be prestigious.

The three scholars who initiated these studies (Campbell, Walberg, & Wu-Tien Wu) were experienced cross-cultural researchers. They wanted to conduct parallel studies in different countries. The international criterion eliminated many of the elite American competitions and left only the ISEF and the Olympiads as possibilities. The second criterion -- not to have any contact with the sponsoring organization -- was used because we wanted to do analyses and evaluations that were independent from organizations running the competitions. The third criterion was added -- to select contests with the fewest winners -- because we had some experience with following up winners of the Westinghouse Science Talent Search (currently Intel Science Talent Search, STS). Subotnik and her colleagues (Subotnik, 1988a, 1988b; Subotnik, Duschi, & Selmon, 1989; Javin & Subotnik, 2006; Subotnik & Steiner, 1993a, 1993b) did follow-up studies of the Westinghouse/Intel Science Talent Search winners but reported difficulty locating them. Since 1942 the STS has 20,100 winners. Finding so many former participants would be a monumental task. For the same reason ISEF was rejected because there were too many annual participants. Finally, the Olympiad competitions were selected because each domain contest is limited to 20 national winners per year. The Olympiads also satisfied the last criterion by having international reputations for excellence.

## Olympiad Studies

The sports Olympics are conducted every four years, while the academic Olympiads are run every year. Both of these competitions are built on the same model of selecting national teams that travel to an international host city and compete for medals. The American academic teams compete for their country with the same sense of pride as the sports athletes.

The first assumption listed above -- children with talent need to be identified early -- was accepted as true by the developers of the first Olympic competition (Soviet Union). In 1934 a series of examinations was initiated to identify the USSR's best mathematics students (Kukushkin, 1996). Once identified, these students were encouraged to enter the technical mathematics, science, and engineering pipelines. In time, the Soviet Union extended the competitions to include other technical areas, and their use spread to other European countries. In 2009 the same line of reasoning led 104 countries to compete in the International Math Olympiad (IMO), 66 countries to compete in the International Chemistry Olympiad (IChO), and 68 countries to compete in the International Physics Olympiads (IPhO). These countries sponsor academic contests as a way of identifying and developing their most talented science and mathematics students.

Table 1.1 illustrates the sponsoring organizations, the age ranges of the former participants, and the number of cohorts being followed.

Insert Table 1.1 about here

The American Olympiad studies involve three separate competitions; namely, the Math Olympiad (www.unl.edu/amc/), the Chemistry Olympiad (www.acs.org ), and the Physics Olympiad www.aapt.org). For a description of these Olympiads consult Wikipedia (http://en.wikipedia.org/wiki/). These competitions start when high school teachers and guidance personnel select their most knowledgeable students to take a series of demanding tests. Some of these teachers select capable students and implement preparation programs that proceed for months.

To illustrate the testing process, the first round of the American Math Olympiad (AMO) involves 250,000 or more students; the second round of testing is given to those students who have the highest scores; and the third round of testing is used to isolate the top 20 students.

The 20 students who survive the testing are then invited to a summer camp where they are given intense training as preparation for the international competition. At the end of the camp, the top 5-6 students are identified, and this team is flown to the host city in Asia, Eastern Europe, Europe, or in the Americas. The 2009 IMO was held in Bremen, Germany, where 565 young mathematicians from 104 countries competed for medals. In the same year, the IChO was held at Cambridge, England, where 258 students competed from 66 countries (http://www.icho2009.co.uk); and the IPhO was held in Mérida Yucatán, México, where 315 students competed from 68 countries (http://ipho2009.smf.mx/marks).

The major difference between the sports and academic Olympics concerns the size of the national sports delegations and the wide age range for the athletes. For the sports Olympics, the size of the different national Olympic teams varies greatly with large countries such as Russia, China, and the U.S. fielding large teams of athletes, while other countries sponsor very small contingents. The age range of the athletes also varies widely, but for the academic Olympiads, the students are roughly the same age, and the delegations are all the same size.

This testing regimen in the U.S. represents some of the most difficult competitions for high school students. An investigative journalist (Steve Olson, 2004) embedded himself with the 2001 AMO winners and documented this reality. In the book he produced (*Count down: Six kids vie for glory at the world's toughest competition)* he follows the 20 young mathematicians during their summer camp training and then accompanies the six students that competed at the IMO. His report explores the challenges these students face as they compete.

The students selected for the American Math Olympiad summer camp represent the top .00008% of the students that participate. In Mainland China, over one million mathematics students take tests before the top 20 students are identified (.00002%).

The United States did not launch any academic Olympiad program until 1972 when the Mathematics Olympiad was started (Turner, 1978). However, countries in both Eastern and Western Europe began these international Olympiad competitions in 1959 for the IMO, 1967 for the IPhO, and 1968 for the IChO.

What skills and preparations are needed to win these academic contests? The tests used in the three Olympiads are constructed by scientists and mathematicians in each domain. These subject matter tests delve into current research problems in each domain. To do well the student must accumulate extensive subject matter knowledge to the point where he or she is able to understand the current research literature and analyze problems confronting scientists, engineers, and mathematicians in that domain. This acquisition of knowledge takes months or even years to assemble. This acquisition of knowledge causes these students to leapfrog over their high school peers.

Critics (Diegmueller, 1996) dismiss competitions because there are so few winners and many more participants who do not win the contest. However, some of the nonwinners also benefit by acquiring in-depth subject matter knowledge that they will use later in their academic careers. Some of them learn to read the research literature, and this accomplishment requires discipline and effort. These skills and attributions will pay dividends later in their lives (Campbell, 2002).

Figure 1 provides an overview of the Olympiad studies from their inception in 1995. The second round of data collection occurred in 1998 with the Mathematics, Chemistry, and Physics Olympians from the United States, Taiwan, Germany, and Finland. The third round took place in 2006 and involved the Mathematics, Chemistry, and Physics Olympians from the United States, Germany, Korea, and Finland.

Insert Figure 1 about here

The original goal was to have parallel studies under way in the United States, Asia, Europe, Scandinavia, and Russia, together with one or more of the former Soviet Union's satellite countries. These parallel studies use identical surveys and instruments and also use the same methods and procedures to analyze the data. Since the USSR initiated these academic Olympic competitions with their Eastern Europe allies, it follows that they would have generations of participants to study. The first wave of data collection was limited to only the United States, China, and Taiwan. Researchers from Russia and Japan were invited to join in this effort, but the principal investigators selected were not able to collect any data. For the second and third waves of data collection, we were fortunate to get principal investigators in

Germany and Finland. Invitations were sent to senior scholars in Romania, Russia, and Cuba, and for a time we thought we had commitments, but problems concerning funding or other obstacles eliminated these countries from participating.

Invitations to join in the Olympiad studies were limited to researchers with the expertise needed to conduct qualitative/quantitative cross-cultural studies. The principal investigators we selected were senior scholars who were open to collaborative efforts. One by-product of these collaborations has been the cross-fertilization of methods and ideas. The principal investigators have published together and have benefited from their varied viewpoints and areas of expertise (Campbell, 1996a; Campbell, Tirri, Ruohotie, & Walberg, 2004).

## Research Questions

The research questions addressed in these studies:

> Do the Olympians make important contributions to society? (Do they fulfill their potential? Do the Olympiad competitions serve the national purpose?)

The research question is, in essence, the fifth assumption listed above. In order to answer this question we used the following subset of research questions:

1a) What colleges/universities did the Olympians attend? How many doctoral degrees did the Olympians earn?

1b) What careers did the Olympians select? Are they doing well in their careers?

1c) Did the Olympians remain in the field originally identified?

1d) How productive are the Olympians? How many publications did they produce?

In addition to these research questions our researchers evaluated the effects of the Olympiad programs by asking the following questions: What effect did participation in the Olympiad program have on these talented individuals? Did it widen their horizons? Did it open doors for them? Were there negative side effects?

We asked the Olympians and their parents to judge the Olympiad experience and the long-term effects of participation.

## Methods and Instruments

The Olympiad studies are organized around the Walberg Productivity Model (Walberg, 1986; Walberg, Fraser, & Welch, 1986; Walberg & Zeiser, 1997; Wang, Haertel, & Walberg, 1993) . The Olympians were mailed a questionnaire that contained 14 pages of questions together with the *Self-Confidence Attribute Attitude Scales* (SaaS). This instrument is designed to produce attribution scales that are related to motivational theory (Campbell, Heller, & Feng, 2004; Fennema, 1983; Fennema & Peterson, 1986; Heller, 2002; Heller & Ziegler, 1996; Weiner, 1994). Their parents were mailed the Parents' Questionnaire that contained 10 pages of questions and Campbell's *Inventory of Parental Influence* (IPI). The IPI produces scales that apply to parental influence theories, typologies, and paradigms (Bronfenbrenner, 1986; Campbell, 2010; Campbell, 2006; Campbell & Verna, 2004; Campbell & Verna, 2007; Epstein, 1995; Epstein & Dauber, 1991; Epstein, Salinas, & Horsey, 1994; 1983; Hoover-Dempsey & Sandler, 1997). Dillman's (1978, 1991) *Total Design Method* (TDM) was followed in the layout of each questionnaire, the placement of questions, and the mailing schedule. Dillman's TDM has been designed to produce a response rate of 70%. We used this percentage as our goal in every round of data collection in each of the subject domains. To achieve this high rate of responses, we sent packages of our instruments over and over again to the nonrespondents explaining to them that they represented a unique sample that really could not be duplicated. Over the 12-year period of collecting data, some Olympians would ignore our invitations only to respond during the next wave of collection. Forty of the American Olympians responded to two waves of data collection by filling out each of the surveys and instruments a second time. We used this extra data to validate the original data submitted.

There are overlapping sections in the Parents' and Olympian's questionnaires, including home/school influences, college/graduate school experiences, impact of the Olympiad program, and background information. The overlaps were done to make sure that data collected could be verified. The goal was to establish the validity of the information that was collected. The methods used in the Olympiad studies are described in more detail in other sources (Campbell, 1996b; Campbell, Tirri, Ruohotie, & Walberg, 2004).

Descriptions of the *Self-Confidence Attribute Attitude Scales* (SaaS) and the *Inventory of Parental Influence* (IPI) and the methods used to derive the different scales are also available in published sources (Campbell, Heller, & Feng, 2004; Campbell & Verna, 2004, 2007). Other articles in this theme issue utilize some of the scales that are produced from these instruments.

The evaluation of the Olympiad programs used two pages of questions. Four of these questions were open-ended where the Olympian could supply qualitative feedback. The information from these questions has been published elsewhere (Campbell, 1996c). The other seven questions supplied space for comments or explanations. The only evaluative question with a yes or no answer asked if the Olympian would have accomplished as much without the program.

## Description of the American Olympians

Over the years of data collection, Campbell, Feng, and Verna secured responses from 345 winners of the American Math (N=124), Physics (N=92), and Chemistry (N=140) Olympiad programs. Ninety Olympians were in high school or college (ages 15-22)(76 males, 14 females), 131 were getting their graduate degrees or were in the work force (early careers) (ages 23-29)(117 males, 14 females), and 124 were occupied in their professional careers (mature career) (ages 30-51)(115 males, 9 females)(Campbell, Wagner, & Walberg, 2000; Campbell, 2000; Feng & Campbell, 2000; Feng, Campbell, & Verna, 2002; Feng, Campbell, & Verna, 2001; Verna & Campbell, 2002; Verna & Campbell, 2000; Verna & Feng, 2002).

We received responses from substantial percentages of these Olympians (94% Math Olympians, 70% Physics Olympians, 68% Chemistry Olympians). We had difficulty in maintaining valid mailing addresses/computer email addresses because of the mobility of the Olympians. We used three different addresses to track the Olympians (home, work, college), but over the years one or more of these addresses became invalid. We also used the parents' addresses to continue the tracking, but again the mobility of these families made it difficult for us to have any way of maintaining contact. We were still able to secure responses by repeated mailings and placing phone calls or sending email messages. The number of viable Olympians in each domain was calculated by subtracting those with obsolete or invalid mail/email addresses and phone numbers that were no longer operative. Only two Olympians refused to participate and sent us letters to this effect. The main complaint we had from the nonrespondents was that our packet of surveys and instruments was too long and took too much time to complete.

Table 1.2 summarizes the demographic data of the American Olympians. This sample consists of 89% males, 11% females, 75% Caucasians, and 24% Asian Americans (with 1 Hispanic and 1 African American). While the Olympian was growing up, the family structure consisted of 11% one-parent families and 89% two-parent families. In terms of immigration, 11% of these Olympians are immigrants, 33% are the children of one or both immigrant parents, and 56% are third generation Americans where every family member was born in the United States. In terms of socio-economic status, the mean was 82.71 (SD 12.51)(Nam & Boyd, 2004; Nam & Powers, 1983). Miller (1991) summarized group occupational status scores for the Nam-Powers-Boyd scale to be 85 for professionals, technical, and kindred occupations, and 79 for managers, officials, and proprietors. In terms of SES, the families of the Olympians originate from both sets of occupations, and come from across the United States.

Insert Table 1.2 about here

## Results

The findings that are reported in the results section deal only with the American Olympians. Let us now answer the subset of research questions.

*What colleges/universities did the Olympians attend? How many doctoral degrees did the Olympians earn?*

The Olympians were successful in earning degrees from the most prestigious colleges/universities (see Table 1.3). This table simply lists the 20 institutions where most of the Olympians earned degrees.

Insert Table 1.3 about here

The top five universities are Harvard, MIT, Princeton, U.C. Berkeley, and Stanford, and the other 15 listed in the table constitute an elite set of universities. The extent of the Olympians' graduate training is evident from the fact that Olympians pursued their advanced degrees in the same institutions listed above. One hundred seventy-nine Olympians (52 %) completed, or are in the process of completing, doctorate degrees (MD; Ph.D.; JD)(Math 57%; Chemistry 49%; Physics 41%). Among the doctorate degrees there are 10 law degrees and 26 MDs. How does this degree data compare with other studies conducted with gifted young adults? The best known study that compiled such data was the Terman (1954; 1959) longitudinal study that followed more than one thousand gifted individuals into adulthood. Terman wanted to find out if the intellectually gifted he identified as children became productive adults. This question is summarized in the popular expression in vogue at the time, "early ripen, early rot." Essentially, we are asking the same question. He reported that 26.3% of 800 gifted males had their doctorate or law degrees, whereas more than half of the academic Olympians (males and females) earn such degrees.

Terman died in 1959, but the longitudinal study he started will continue until 2020 to encompass the entire lives of the original 1,528 individuals identified (http://www.hoadiesgifted.org/eric/faq/gt-long.html). The results were published in a series of books (Terman, 1925, 1930, 1947; Terman & Oden, 1959), and scholars continue to publish articles about this longitudinal study (Hastorf, 1997; Holahan, 1996; Rogers, 1999; Vialle, 1994; Zuo, 1999; Zuo & Cramond, 2001)

*What careers did the Olympians select? Are they doing well in their careers?*

There are 138 Olympians (40%) who have selected careers in academia -- teaching at colleges or universities or doing research. One hundred seventeen Olympians (34%) have careers outside academia (see Table 1.4). Thirty-nine Olympians are pursuing science and engineering careers, 21 are employed in computer areas, and 10 are employed in the business sector. Forty-seven are employed in a variety of other occupations.

Insert Table 1.4 about here

There is no way to determine the contribution made by the Olympians in the nonacademic community, but the job titles indicate a number of responsible positions. The most financially successful might include the 10 Olympians employed by financial institutions on Wall Street. One is an executive at the prestigious Salomon Brothers; one is a bond trader; one is an associate with Goldman Sachs; and two are financial analysts with major banks. One of the 10 lawyers was the council for the mayor's office in one of the largest cities in the United States.

Of the 21 Olympians employed in the computer industry, two founded software companies, two are currently the CEO of their companies, and another remains an executive with his company. Another Olympian is the executive director of a nonprofit corporation.

For the scientists or engineers, one is a principal engineer with nine patents; another is a scientist at Los Alamos National lab; two are researchers at the Bell Labs (AT&T); two others are senior scientists at IBM; one is a scientist with DuPont; and one is a scientist at Raytheon.

Two of the Olympians are Talmud scholars, and one is on the way to becoming a priest. Four of the Olympians are teachers, and two of them co-authored two textbooks. Another Olympian founded a journal that is in its 14th year, and another is a correspondent with a science magazine. One Olympian performed with a musical ensemble at Carnegie Hall; another is an independent filmmaker, and still another works at the United States State Department.

*Did the Olympians remain in the field originally identified?*

This research question is difficult to answer because there are so many fields that have connections to the original three domains where the Olympians competed. Twelve Olympians are national winners in two Olympiad competitions. With 10 Olympians securing law degrees and 25 becoming medical doctors, it is evident that these 35 individuals did not select careers within the domain where they won early distinction.

For the Chemistry Olympians, two earned law degrees and 20 have MDs. Six Physics Olympians have law degrees and five have MDs, and the Math Olympians have produced two lawyers. There are also linkages with math and computers, and 21 Math Olympians have selected careers in this domain. The 39 scientists, and especially the 57 Olympians listed under ‘Other Occupations’ in table 1.4, have all veered into careers that are not strictly within the original domain. Americans are known for their flexibility, and it should come as no surprise that they gravitate into a myriad of careers outside of the domain that interested them in high school.

*How productive are the Olympians? How many publications did they produce?*

How successful are these Olympians? One measure of postsecondary faculty and staff productivity involves tabulating the number of publications produced. The 345 Olympians produced a total of 8,629 publications (see Table 1.5).

Insert Table 1.5 about here

Table 1.6 provides the total publications for the three age cohorts. The bulk of these publications were written by Olympians in their thirties or forties. The youngest cohort averaged 5.09 publications, the early career Olympians averaged 15.86 publications, and the mature career Olympians averaged 49.14 publications. In a separate article in this theme issue we contrast the most and least productive Olympians. The most productive ones account for a disproportionate number of these publications (see Campbell & Feng).

Insert Table 1.6 about here

The United States National Center for Educational Statistics is currently conducting a national study of 11,000 higher education faculty in 480 institutions (National Survey of Postsecondary Faculty -- NSOPF) (Kirshstein, Matheson, & Jing, 1997). The NSOPF data for

1992 shows the average number of publications for all college faculty was 4.6 per year. However, the faculty publication rate was much higher at research institutions (7.35/year for public colleges/universities; 7.95/year for private ones).

Some Olympians have higher publication rates than the NSOPF faculty. Four of the Olympians have over 100 publications, and eight Olympians in their 30's have produced between 50 and 99 publications. These academic "stars" are in positions of leadership. For example, at 44 years of age one is director of Whitehead/MIT Center for Genome Research and has made contributions to cancer research. He has published 229 articles, research papers, technical reports, and two books, and serves on 12 editorial boards. Another 46 year old Olympian serves as the editor for two journals, published one book, has 6 chapters in books, 51 articles in refereed journals, and 37 research papers. He is active in research dealing with electrical and computer engineering projects, and in 1994 served as a member of the Defense Science Board studying Cruise Missile defense.

*Evaluation of Olympiad Programs*

Would the Olympians have turned out as well without the Olympiad programs? This is a fundamental question we asked the adult Olympians and their parents. This is especially significant when asked 10-30 years after the Olympiad experience. Both the Olympians (72%) and their parents (70%) expressed the view that they would not have accomplished as much without the programs. As time passes, the Olympians earn degrees, start careers, become established in their fields, yet they weigh all these milestones and still rate their participation in the Olympiad program as important to their overall accomplishments. How many high school experiences could be expected to continue to be evaluated so positively?

When asked if the programs helped or hindered the acceptance of their talents, 64% of the Olympians and 75% of their parents concluded that the program helped. Only 4% of the Olympians and none of the parents thought the Olympiad programs hindered the development of their talent in any way. The qualitative data that accompanies this question substantiates the percentages listed above. Their explanations for such positive answers include: “confirmation of my abilities,” “realization I had potential,” “discovering I had the right to believe in my own abilities,” ”a chance to be recognized,” ”made me aware for the first time that my talent was really unusual,” ”validated my talent,” ”it helped me gage my talent,” and “first indication I had of how good I really was.”

After the first publication of the Olympiad findings in 1996 (Campbell, 1996a), Karp (2003) did a follow-up study of the 1969-1973 St. Petersburg academic Olympians. His key finding is that the majority of these Olympians view their participation as beneficial and not as negative (cut-throat competition).

It is important to emphasize that our research team has no connection with any of these Olympiad programs. Our evaluations are independent from the organizations that run the Olympiads.

## Conclusions

*Do the Olympians make important contributions to society? (Do they fulfill their potential? Do the Olympiad competitions serve the national purpose?)*

These research questions refer back to the fifth assumption -- Once developed, this talent is expected to contribute to society. When the contributions of the Olympians are summed, including the number of doctorate degrees earned, the number of Olympians working as professors (many in technically needed areas), the number of scientists (some in sensitive and needed areas), the 8,629 publications produced, the number of Olympians working in the computer industry, including several who have founded or managed software companies, we must conclude that the Olympians serve the national interest. They do make important contributions, and a number of them fulfill their high potential. Overall, the quality of their contributions outweighs their small numerical numbers. Many of the Olympians are working in leadership positions that magnify their influence.

It must also be remembered that many of these contributions listed above are limited to the oldest Olympiad cohort (124 individuals between the ages of 30-51). These Olympians are in the prime of their careers and can be expected to make many more contributions over the next 20 to 30 years. Furthermore, the younger cohorts can also be expected to assemble a long list of their own contributions.

The Olympiad studies also shed some light on two of the other assumptions. Assumption 3 -- Contests will attract participants with extraordinary talent. The German Olympiad study (Heller & Lengfelder, 2000) found that many of the schools in Germany did not participate in the Olympiad studies even though their students had sufficient talent to compete. The same problem occurs in the United States where many schools should routinely enter their capable students in the Olympiad competitions but do not.

Furthermore, in the German (Lengfelder & Heller, 2001, 2002) and Korean Olympiad studies (Cho, 2001), many teachers did not nominate bright female students that had the capability to do well in these competitions. This systematic bias may be cultural in nature, though the same bias has also been found in American schools (Feng, Campbell, & Verna, 2002). Consequently, our data does not support this assumption.

The other assumption where we can report findings is Assumption 2 -- Competitions are needed because many schools do not have the differentiated curriculum or the resources that are needed to challenge extraordinary students. The qualitative data from the American Math study (Campbell, 1996b) is especially relevant here. Some of the United States Math Olympians report intuitively grasping the underlying algorithms of much of the math taught to them in elementary school. These precocious children realized that some of their teachers did not understand this basic information. This realization caused the Olympians to lose respect for these teachers and caused the teachers to view these precocious students as threats.

How can we challenge such advanced children with the regular curriculum that is provided in most elementary and secondary schools? Some of the competitions encourage students to work at college or research labs where the work is far beyond anything being taught in their science classes (Campbell, 1985). Most schools simply do not have the resources to match the facilities and equipment available at these institutions. It is more sensible for schools to funnel such capable students into these advanced labs for the challenges that are not available in the conventional high school.

## Generalizing to Other Competitions

Having evaluated three Olympiad competitions, what inferences can be made about other American competitions? Do they also serve the national interest? Our major findings should certainly apply to the other elite competitions. It is reasonable to infer that the Intel Science Talent Searches, the Junior Science and Humanities Symposia, the SMPY programs, and the ISEF Science Fairs, all funnel talented students into productive careers.

The cost of these American competitions is surprisingly low. Participation in the three Olympiad programs together costs approximately $100 (US)/school. The costs for the science fairs, the Intel STS, the JSHS, and the ISEF science fairs are paid by companies, foundations, or by the government. For the most part, students competing in these contests use resources outside the schools.

Our message to the professional sponsors and the scientists, engineers, mathematicians, and social scientists that devote so much of their time and energy to these competitions – your time is well spent. The same message can be delivered to the many teachers at the grass root level who instinctively understand the potential of these contests. Both groups can be assured that the United States is better off because of their unselfish efforts.

The message to other teachers is to think about the possible benefits to the very talented students in your classes. Can these talents be challenged by entering these students in one of the competitions that are underway at every grade level in every subject area? Even if your school does not have a program for the gifted, it is always possible to find a competition that could simulate a talented student. The teacher would need to provide guidance and must be willing to work with this student individually. Remember, once you develop a child's talents, this development can have ripples over the course of that individual's lifetime.

Campbell (1985, 1988, 1992) studied the impact of the Intel STS on the participants and found that in order to succeed in this competition the students need to develop the following skills, attitudes, and orientations: learn to manage time; develop the library skills needed to conduct technical searches; learn how to read scientific and other advanced material; develop the organization skills needed to manage a research project; and finally, develop the discipline needed to conduct scholarly research studies or to learn how to study for challenging examinations. These enhanced skills not only help the student do well in the contests but can also be applied in future schooling or later in their careers. Even if participants do not win the contest, these newly developed skills will prove very useful. In this sense there are no “losers” in a competition where the participants learn things they can use to enhance their development.

## Recommendations

In an era of ever rising costs for schools, it is refreshing to find cost-effective, inexpensive ways to develop the talents of gifted students. The following recommendations are warranted:

- Talented students exist in every American high school, and therefore participation in the Olympiad programs and in other elite competitions should become the rule not the exception.
- Talented females and minority students need to be encouraged to participate in the elite competitions; therefore, programs need to be institutionalized for this purpose.
- Principals and leadership teams should realize their roles in developing extraordinary talent. Schools that produce winners to competitions gain reputations that benefit the whole school and their communities.
- Teachers that are successful at producing winners year-by-year should be recognized, and a reward system should be instituted for such teachers.

Finally, Tannenbaum (1981) observed that a pendulum exists in providing programs for the talented and gifted in the United States. One extreme emphasizes the development of talent that the nation needs (meritocracy). This extreme, however, leads to accusations of elitism that jeopardize gifted programs. At the other extreme, egalitarianism (equality for all) is the driving force behind the elimination of many tracking programs that have served the gifted. The older Olympians send us notes stating the gifted programs that helped them in developing their talents are being demolished in favor of equity programs for minorities. We have no quarrel with schools providing equity programs, but such programs should not replace programs that are needed to develop the nation's technical talent that is so vital to the nation's survival.

## Authors Note

No identification of the Olympians or the titles of their books or other products are provided in this article because we promised strict confidentiality and are committed to protect this pledge.

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Table 1
*American Olympiad samples and sponsors*

| | Math | Chemistry | Physics |
|---|---|---|---|
| N | 125 | 140 | 92 |
| Starting year | 1972 | 1984 | 1987 |
| Cohorts/years | 36 | 24 | 22 |
| Age range | 15-51 | 15-42 | 15-39 |
| Sponsor | Mathematical Association of America | American Chemical Society | American Association of Physics Teachers |

*12 Olympians are national finalists in two domains making the N=345

Table 2
*Description of the American Olympians from 2009 Synthesis*

N=345

| | |
|---|---|
| **Gender** | |
| Males | 89% |
| Females | 11% |
| **Ethnic Group** | |
| Caucasians | 75% |
| Asians | 24% |
| Hispanics | .3% |
| African Americans | .3% |
| **Family Structure** | |
| One-Parent family | 11% |
| Two-Parent family | 89% |
| **Generation** | |
| 1st Generation (Immigrants, born overseas) | 11% |
| 2nd Generation (Children of one or both immigrant parents) | 33% |
| 3rd Generation (Parents & Olympian born in US) | 56% |
| **Socio-Economic Status** | |
| Mean=82.7173 | |
| SD=12.51 | |

Table 3
*Colleges and Universities Attended by Olympians*

| Colleges/ Universities | Number enrolled Undergraduate | Number enrolled Graduate | Total enrolled |
|---|---|---|---|
| Harvard | 66 | 40 | 106 |
| MIT | 35 | 27 | 73 |
| Princeton | 23 | 14 | 37 |
| U.C. Berkley | 9 | 21 | 30 |
| Stanford | 12 | 17 | 29 |
| Cal. Tech. | 13 | 9 | 22 |
| U. Chicago | 5 | 12 | 17 |
| U. Illinois | 5 | 8 | 13 |
| Duke | 8 | 4 | 12 |
| Cambridge (UK) | 4 | 6 | 10 |
| Rice | 8 | 2 | 10 |
| Cornell | 4 | 4 | 8 |
| Carnegie Mellon | 5 | 2 | 7 |
| U. Michigan | 5 | 2 | 7 |
| Yale | 4 | 3 | 7 |
| Northwestern | 3 | 3 | 6 |
| UCLA | 1 | 4 | 5 |
| Oxford (UK) | 4 | | 4 |
| Columbia | 2 | 2 | 4 |
| Johns Hopkins | 1 | 2 | 3 |

Table 4
*Olympians' Occupations (not in Colleges and Universities)*

| Number | Occupation/ Job Title |
|---|---|
| **Computer Occupations** | |
| 5 | Computer Programmer/Analyst |
| 2 | Computer Music Companies |
| 2 | Software Developer |
| 5 | Software/Hardware Engineer |
| 2 | Founded Software Companies |
| 1 | Software Company Exec. |
| 1 | Founder Internet Co. |
| 1 | Director Product Design (Software) |
| 1 | Microsoft Program Manager |
| 1 | Computer Programmer/Algorithm Designer |
| **Scientific Occupations** | |
| 35 | Scientists/Engineers (including 1 Principal Engineer with 9 patents, 1 at Los Alamos Nat. Lab, 2 at Bell labs (ATT) 1 at IBM 1 at DuPont, 1 at Raytheon) |
| 1 | Consultant -- Scientific Programmer |
| 1 | President & CEO Technology Corp. |
| 1 | System Integrator |
| 1 | Product Line Manager |
| **Other Occupations** | |
| 10 | Wall Street (including 4 financial analysts, 1 bond trader) |
| 10 | Lawyer |
| 25 | Medical Doctor |
| 4 | Teacher (2 Authored Text Books) |
| 2 | Talmud Scholar |
| 1 | Priest (Seminary) |
| 1 | Executive Director of Nonprofit Corp. |
| 1 | Correspondent (Scientific Magazine) |
| 1 | Independent film Maker |
| 1 | US State Dept. |
| 1 | Arts Administrator |

Table 5

*Total Publications by Subject Domains*

| Olympiad Subject (s) | Mean | N | Std. Deviation | Sum |
|---|---|---|---|---|
| Math | 44.75 | 117 | 78.905 | 5236 |
| Physics | 10.31 | 84 | 20.497 | 866 |
| Chemistry | 18.11 | 132 | 44.063 | 2391 |
| Math & Physics | 17.75 | 4 | 21.109 | 71 |
| Math & Computers | 16.50 | 2 | 23.335 | 33 |
| Math & Chemistry | .00 | 2 | .000 | 0 |
| Physics & Chemistry | 8.00 | 4 | 11.804 | 32 |
| Total | 25.01 | 345 | 56.201 | 8629 |

Table 6

*Total Publications for Age Cohorts*

| Age Cohort | Mean | N | Std. Deviation | Sum |
|---|---|---|---|---|
| Young (16-22) | 5.09 | 90 | 14.204 | 458 |
| Early career (23-29) | 15.86 | 131 | 34.395 | 2078 |
| Mature career (30-51) | 49.14 | 124 | 80.442 | 6093 |
| Total | 25.01 | 345 | 56.201 | 8629 |

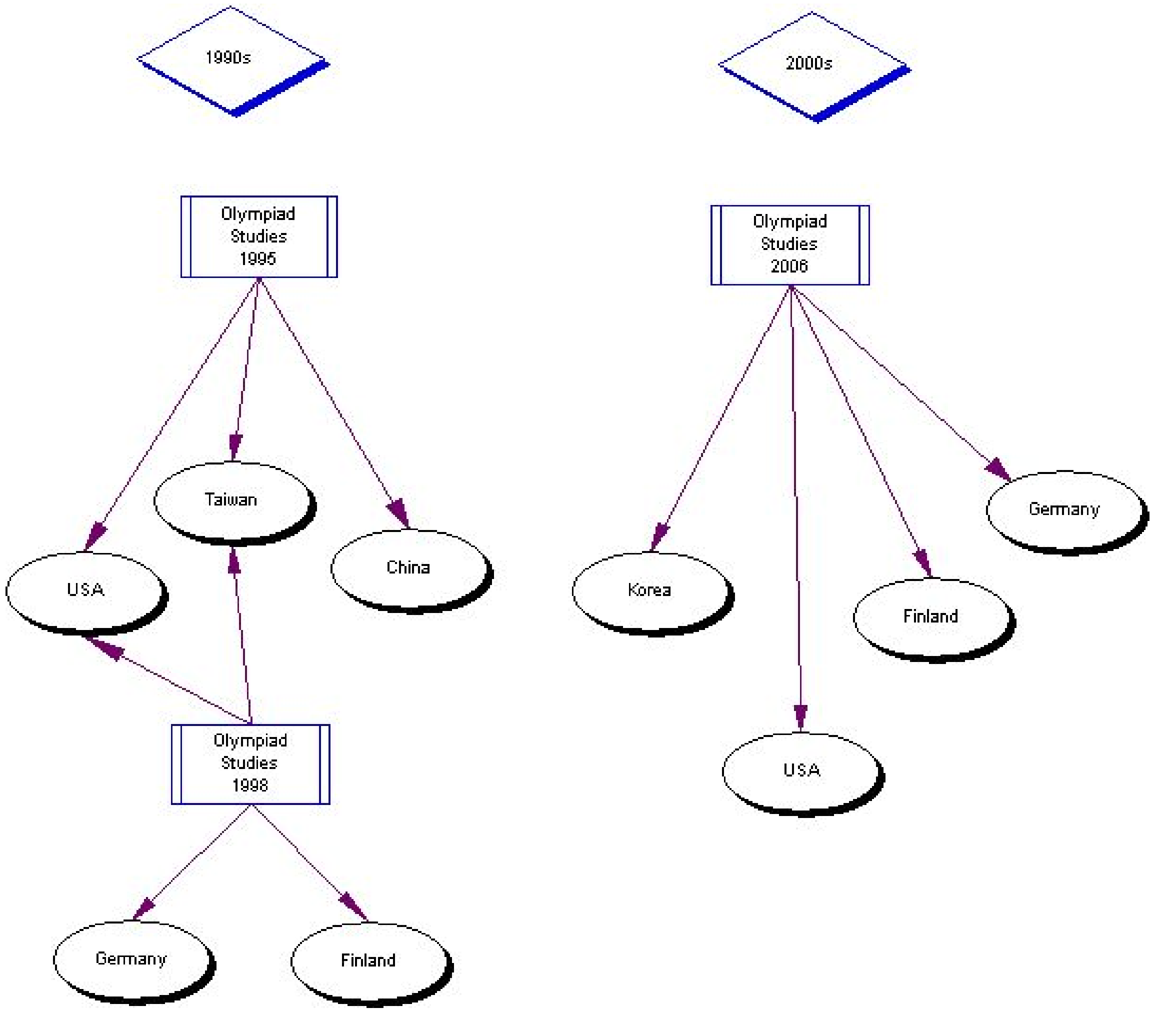


Figure 1 Olympiad Studies.