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# Cross-cultural predictors of mathematical talent and academic productivity

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The main goal of this paper is to investigate cross-cultural factors that predict academic ability among mathematically gifted Olympians in Finland and the United States. The following two research problems are formulated: (1) What factors contribute to or impede the development of the Olympians' mathematic talent? and (2) Do the Olympians fulfill their potential by making contributions to their fields? The results regarding the first research question indicate that the amount of cross-cultural distinctive factors (computer literacy) is less than the amount of connective factors (school hindrances, effort attributions, negative home influences) contributing to the development of the Mathematic Olympians' talent. The results regarding the latter research problem show that some factors are culture invariant (socioeconomic status, effort attributions) and some are culture dependent (school hindrances, computer literacy) in relation to both US and Finnish Olympians' later academic productivity. Results show that high school grade point averages do not necessarily predict academic productivity in Olympians' careers.

## Introduction

The major goal of this paper is to investigate cross-cultural factors that predict academic ability among the mathematically gifted population. The population is represented by those Finnish and US students who participated in the Mathematic Olympics during a period of some thirty years (Finnish 1965–1997, American 1972–1995).

According to the Organisation for Economic Co-Operation and Development (OECD) Programme for International Student Assessment (PISA) 2000, Finnish

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15-year-olds scored above the OECD average in mathematics literacy. Students of the same age from Japan, Korea and New Zealand ranked the highest of all the students of participating countries. However, students from the United States scored below the OECD average in mathematics literacy. This result leads us to predict that the Finnish Olympians might score higher than the US Olympians in computer literacy as well (OECD, 2002).

The research problems considered in this study are twofold: (1) What factors contribute to or impede the development of the Olympians' math talent? and (2) Do the Olympians fulfill their potential by making contributions to their fields?

The study is part of an international research project that compares the opportunities for gifted people in different countries to actualize their giftedness (Campbell, 1996a). Germany, Taiwan (Wu & Chen, 2001) and Korea are also involved in this project. A special interest is shown in the factors of education, both in homes and in schools, that have helped or hindered these people in the actualization of their giftedness. Furthermore, the self-perceptions of the Olympians regarding the attributions of ability and effort in their success are investigated within the theoretical framework of Weiner's theory (1980, 1994). The official educational policy in Finland advocates increasing studies in science and mathematics. Computer skills and the new information technology have also received special attention in the national Finnish educational strategy (Ministry of Education, 1995). Finland has participated in Olympiad programs for several years. Separate programs exist for the Math, Physics and Chemistry Olympiads. In the Math Olympiad programs, series of increasingly difficult tests are administered. This testing concludes with the identification of the top national finalists (6–20 Olympians). These individuals are trained to compete in the International Olympiad programs.

Since 1995, the US have used three tests to identify Math Olympians. In the first stage, 350,000 students participate in the American High Mathematical Examination (AHSME) test. After that, the top five per cent of the participants take the American Invitation Mathematical Examination (AIME). The top six scorers (0.002 per cent) are identified as Math Olympians (Campbell, 1996b).

The previous studies concerning mathematics achievement have revealed that the home background of students, number of students in class and attitudes of students towards mathematics are student-level factors influencing achievement in mathematics over the last 30 years (Afrassa & Keeves, 1999).

Social values associated with cross-national differences in mathematics achievement are addressed in recent study by Shen (2001). The results suggest that economic development level, as measured by GNP per capita, has a positive but weak effect on mathematics achievement. Variables reflecting a society's value on education (i.e. students' perceived rigour of mathematics, students' school attendance and the number of parents living with the student) demonstrate strong effects on students' mathematical achievement (Shen, 2001, pp. 202–210).

The research findings on gender differences in mathematics achievement can be collected, according to Jo Boaler (2000), into four facts. These facts are as follows: (1) Gender differences in mathematics are generally small and insignificant when

considered alongside the overlap between males and females; (2) achievement differences have vastly diminished over time; (3) the greatest differences in mathematics achievement and participation are found at the highest levels. The evidence for achievement differences consists of results from short, closed tests, such as SATs in the US, and the international Olympiad tests. These tests persistently prompt small gender differences in favor of boys; and (4) gender differences have tended to recur in the past in mathematics questions that assess spatial ability and problem solving (Boaler, 2000, pp. 29–30). According to Heller and Ziegler (1996), girls' and women's self-related cognitions in mathematics and the sciences occupy a key role in understanding gender differences. The females tend to underestimate their own talents; from a motivational perspective, they attribute their successes and failures in such a way as to further inhibit motivation (Heller & Ziegler, 1996).

In this paper, we report findings on Olympians of different ages who participated in Olympiad Studies in mathematics during 1965–1997. A special interest is shown in the influences of home and school in contributing to the development of academic talent. The results of the Finnish study are compared to the earlier US study using the same instruments (Campbell, 1996b).

## Methods and procedures

The Olympians both in Finland and the US were mailed a 14-page questionnaire and self-confidence attitude attribute scales (SaaS) (Campbell, 1996a). Their parents were mailed a shorter version of the same questionnaire and the inventory of parental influence (IPI) (Campbell, 1996a).

The validity of a self-rating instrument is affected by the same defects as any rating system. In general for rating systems, the following three types of error are often associated with rating scales: the error of severity ('a general tendency to rate all individuals too low on all characteristics'), the error of leniency, ('an opposite tendency to rate too high') and the error of central tendency, (a 'general tendency to avoid all extreme judgments and rate high down the middle of a rating scale') (Kerlinger, 1973, 548–549). The general response tendency in this study shows that the Olympians' and their parents have used all the options in their answers.

Four of the Finnish and two of the US Olympians were no longer living, and ten Finnish and six US Olympians kept their current addresses private or could not be located. The Finnish sample consisted of 72 Math Olympians and 69 of their parents. The US sample consisted of 80 Olympians and 55 parents. The Finnish Math Olympians' data came from 68 males and four females. All the US Olympians were males. The total number of Finnish females who participated in the Olympics during 1965–1997 is fourteen. That is far more than the number of the US female participants (during 1972–1995), a total of two. The Finnish data includes Olympians of different ages, ranging from 20 to 54 years of age. The US participants are far younger, the youngest being 15 and the oldest 41 (see Table 1). For more specific background mapping of the Olympic study, see Tirri (2001) and Campbell (1996a).

Table 1. Description of the Finnish and American Math Olympians

| | Finland (N=72) | | US (N=80) | |
|---|---|---|---|---|
| | (N) | (%) | (N) | (%) |
| *Sex* | | | | |
| Male | 68 | 94 | 80 | 100 |
| Female | 4 | 6 | 0 | 0 |
| *Age group* | | | | |
| - 22 | 6 | 8 | 18 | 23 |
| 23–29 | 15 | 21 | 28 | 35 |
| 30 - | 49 | 68 | 30 | 37 |
| Missing | 2 | 3 | 4 | 5 |

## The factors contributing to the development of mathematical giftedness of the Olympians

The first research question ('What factors contribute to or impede the development of the Olympians' math talent?') is operationalized here by dividing it into a series of subquestions: (1.1) What is the role of socioeconomic factors (SES) in the development of mathematical talent?; (1.2) What factors in school hinder the development of mathematical talent?; (1.3) Do specific family processes inhibit or contribute to the development of math talent?; (1.4) How confident are the Olympians in terms of their academic abilities?; and (1.5) Does computer literacy contribute to the development of mathematical talent?

### *Socioeconomic factors*

A multi-item measure of socioeconomic status (SES) was calculated for each Olympian. We used the guide developed by Nam and Powers (1983) to code occupational and socioeconomic status scores. The Nam–Powers socioeconomic status scores combine education, income, and occupation in a multi-item index, which provides a direct and objective measurement of SES. The advantage of the Nam–Powers scale is that it provides combined scores for men and women.

The Nam–Powers scale was developed from US census data. The scale values are useful internationally only in a relative sense. For example, university professors, medical doctors and teachers are considered high-scoring jobs in both countries. Similarly, farm labor positions are scaled as very low-level positions in both Finland and the US. But the Nam–Power averages for each country might not be precise enough for exact comparisons. This is especially true for developing countries. For highly developed countries like Finland and the US, the scores might be fairly comparable but even here it is important to use Nam–Powers only in a relative sense of status. This is not an absolute scale that can be used across the board in every country.

To calculate SES for each Olympian, we performed the following steps: firstly we categorized both parents' educational level by giving equivalent points according to the scale, secondly we categorized parents' income information, and thirdly we produced a new variable, the Finnish adjusted 'SES' value, by adding education, income and occupation and dividing the outcome by the number of factors.

The SES indices show that a majority of the Finnish (33 per cent) and US (51 per cent) Math Olympians came from homes with a high-level socioeconomic status. The adjusted mean of the Finnish Olympians parents' income was rated in the highest class, as was the mean of the US Olympians' parents' income.

### *School factors*

Most of the Finnish Olympians did not take part in any kind of special educational arrangements for gifted children during their years at school. These arrangements include opportunities to study according to an advanced program or a special class for gifted students. In the US, 89 per cent of the schools are public; 82.4 per cent of the Olympians attended them. In contrast to Finland, over half of the US Olympians were enrolled in gifted classes during their school career.

The Olympians and their parents were asked to rate the importance of school influences to the development of the academic talent of the Olympian (see Table 2). A six-point scale from 0 (no importance) to 5 (great importance) was used. Both Finnish and US parents rated school's negative influences as being more important than did the Olympians. The Olympians, regardless of their socioeconomic status, viewed themselves as the most influential person in the development of their giftedness (Tirri, 2001).

### *Family processes*

The Olympians and their parents were asked to rate the importance of conducive home atmosphere to the development of the academic talent of the Olympian (see Table 3). A six-point scale from 0 (no importance) to 5 (great importance) was used.

Both the Olympians and their parents in Finland and the US rated the item 'Home atmosphere was very conducive to learning' as the most influential factor in their talent development. It is also noteworthy that the parents' perceptions of the home

Table 2. School factors

| | Finland | | US | | |
|---|---|---|---|---|---|
| | (M) | (SD) | (M) | (SD) | *t* |
| *School hindrances* | | | | | |
| Parents' perceptions | 1.47 | 1.09 | 1.24 | 1.29 | 1.05 |
| **Olympians' perceptions** | **1.53** | **1.08** | **2.03** | **0.87** | **–5.77*****|

*p < .05,**p < .01,***p > .001.

Table 3. Conducive home atmosphere

| | Finland | | US | | |
|---|---|---|---|---|---|
| | (M) | (SD) | (M) | (SD) | *t* |
| *Conducive Home Atmosphere* | | | | | |
| **Parents' perceptions** | **2.85** | **0.70** | **3.52** | **0.77** | **–3.82*** ** |
| **Olympians' perceptions** | **2.10** | **0.97** | **3.10** | **0.80** | **–6.70*** ** |

*p < .05,**p < .01,***p > .001.

atmosphere were higher in both countries than were the Olympians'. This finding is expected because parents often report a 'rosier' picture of reality. It is a difficult task to decide whose perception is the more accurate one.

Campbell (1996a) developed international factor scales that isolate five family processes: pressure, psychological support, parental help, press for intellectual development and monitoring/time management. A five-point Likert scale from 1 (strongly disagree) to 5 (strongly agree) was used. Table 4 shows that the Olympians' families provided much more psychological support than pressure in both countries, but in Finland parents provide fewer intellectual resources (2.85) than in the US (3.94). An explanation for this difference is the net wealth of the US parents or the greater availability of such intellectual resources.

### *Olympians' attributions*

The Finnish Olympians emphasized their own interests and efforts as key factors in their talent development. They mentioned 'good memory', 'self-discipline', 'hating to

Table 4. Family processes

| | Finland (N=69) | | US (N=55) | | |
|---|---|---|---|---|---|
| | (M) | (SD) | (M) | (SD) | *t* (N=124) |
| *Pressure* | | | | | |
| Parents' perceptions | 1.84 | 0.40 | 1.91 | 0.55 | .42 |
| *Psychological support* | | | | | |
| **Parents' perceptions** | **3.94** | **0.35** | **4.15** | **0.45** | **2.39*** |
| *Parental help* | | | | | |
| **Parents' perceptions** | **1.76** | **0.42** | **2.71** | **0.79** | **–6.74*** ** |
| *Press for Intellectual Development* | | | | | |
| **Parents' perceptions** | **2.85** | **0.33** | **3.94** | **0.86** | **–5.06** ** |
| *Monitoring* | | | | | |
| **Parents' perceptions** | **1.65** | **0.44** | **2.49** | **0.91** | **–13.86*** ** |

*p < .05,**;p < .01,***;p > .001.

Table 5. Olympians' self-attributions

| | Finland (N=72) | | US (N=80) | | |
|---|---|---|---|---|---|
| | (M) | (SD) | (M) | (SD) | *t* (N=152) |
| *Effort attribution* | 3.18 | 0.45 | 3.21 | 0.62 | –.79 |
| *Ability attribution* | 3.16 | 0.32 | 2.91 | 0.58 | 1.94 |

lose', 'desire to compete', 'my own inner drive' and 'my early learning in math and reading' as important factors influencing their development. The teachers are given credit, too. Ten of the Finnish Olympians reported 'excellent teachers' and 'teachers' active encouragement' as important factors in their talent development (Tirri, 2001). The US Olympians attributed effort to be more important than ability in their success (Campbell, 1996b). This result equals the findings of Taiwan physics and chemistry Olympians (Effort: 3.35, Ability: 2.95) reported by Wu & Chen (2001). Five-point Likert items from 1 (strongly disagree) to 5 (strongly agree) were used in these scales (Table 5).

*Computer literacy*

The US (Campbell, 1996b) and Finnish Olympians reported extensive use of computers. Over seventy per cent owned a computer and about ninety per cent worked daily on a computer. The Finnish Olympians used different software programs more extensively than did their US colleagues, the most distinctive difference being in the use of Internet and database applications that are usually closely related to Internet programming (Table 6).

## Path analysis—GPA

The first research question ('What factors contribute to or impede the development of the Olympians' math talent?') was broken down into a series of separate questions

Table 6. Finnish and US Olympians computer utilization

| | Finland | US |
|---|---|---|
| *Own computer (%)* | 79 | 70 |
| *Work on computer daily (%)* | 92 | 89 |
| *Software programs used (%)* | | |
| Word processing | 97 | 73 |
| Math/Statistics | 56 | 37 |
| Internet | 96 | 46 |
| Database | 32 | 12 |
| *Computer Literacy (Scale: highest 5; lowest 1)* | 4.04 | 4.08 |

that were answered under the previous headings. The next step in this paper in answering the first research question is to apply a multivariate path analysis (see Wright, 1918; Simon, 1954; Wold, 1954; Jöreskog, 1969; Afrassa & Keeves, 1999) to one dependent variable, high school grade point average (GPA) and eight predictor variables. The term 'path analysis' is used here for modeling systems of structural relationships among a set of observed variables (Kaplan, 2000, pp. 13–39). When we concentrate on studying the causal relationships between variables in the model, we exclude the possibility of external causal relationships (i.e., latent variables) and thus avoid the criticism addressed to structural equation modeling in social sciences (Pearl, 2000, pp. 133–171).

The following predictor variables were used in the path analysis: computer literacy factor (Table 6); two school hindrance factors, one from Olympians' and one from parents' perspective (Table 2); effort and ability attributions factors (Table 5); positive home influence factors including parents' factors of support, help, press for intellectual development and conducive home atmosphere (Table 3); negative home influence factors including parents' factors of pressure and monitoring (Table 4); and socioeconomic factors including parents' occupational status, educational levels and the family's income.

Table 7 shows that three of the US Olympians' variables and also three of the Finnish Olympians' variables had significant path coefficients with the GPA variable. In the US data, there were significant negative influences for computer literacy and effort attributions. US students with high computer literacy had lower

Table 7. High school Grade Point Average (GPA)—path coefficients and correlations

| Dependent variable | Predictor variables | Finland (US) mathematicians: Direct effect | | Indirect effect | | Total effect | | r with GPA | |
|---|---|---|---|---|---|---|---|---|---|
| *GPA* | | | | | | | | | |
| | Computer literacy | 0.34* | (–0.30*) | 0.00 | (–0.01) | 0.34* | (–0.31*) | 0.10 | (–0.24) |
| | School hindrance (Olympians) | 0.08 | (0.15) | –0.24 | (–0.07) | –0.16 | (0.08) | –0.13 | (0.06) |
| | School hindrance (Parents) | 0.66* | (0.12) | –0.37* | (0.03) | 0.29* | (0.15) | –0.11 | (0.09) |
| | Effort attribution | –0.12 | (–0.27*) | — | (—) | –0.12 | (–0.27*) | –0.07 | (–0.22) |
| | Ability attribution | 0.01 | (0.16) | 0.00 | (–0.02) | 0.01 | (0.14) | –0.03 | (0.14) |
| | Positive home influence | 0.20 | (0.23*) | 0.01 | (–0.05) | 0.21 | (0.18) | 0.12 | (0.09) |
| | Negative home influence | –0.58* | (–0.11) | 0.14 | (–0.00) | –0.44* | (–0.11) | –0.13 | (–0.11) |
| | SES | –0.22 | (–0.14) | 0.19 | (0.06) | –0.03 | (–0.08) | 0.19 | (–0.05) |

*$p < 0.05$ $R^2 = 0.15$ (0.23)

grades (GPA) because there is no connection to academic courses (Campbell, 1996b). An interpretation of the fact that Finnish Olympians had a positive influence on their GPA from computer literacy and school hindrance factors experienced by their parents could be found in cultural differences. Campbell's (1996a) conclusion regarding low GPAs is that the most computer literate Olympians were spending considerable amounts of time working on computers to pursue their own interests. Perhaps that is not the situation with their Finnish peers, because in Finland all kinds of (game) programming projects requiring mathematical skills are the most popular hobbies of young computer-oriented people. In both countries, negative home influence and socioeconomic status had a negative effect on the GPA. In the Finnish data, the more distinctive effect could be explained by motivational factors; if a student has no 'socioeconomic insurance' or 'domestic role-model', he or she invests more in the development of his or her academic abilities.

In the Finnish data, it is obvious that school hindrance experienced by the parents is the most influential positive variable (0.66, $p > 0.05$), just as the negative home influence is the most negative one (–0.58*, $p > 0.05$). The importance of home atmosphere is also high in the US data (0.23*, $p > 0.05$). As Table 7 illustrates, both computer literacy (–0.30*, $p > 0.05$) and effort attribution (–0.27*, $p > 0.05$) were the most significant negative influences on GPA.

## Actualizing mathematical giftedness in the professional lives of the Olympians

The second research question ('Do the Olympians fulfill their potential by making contributions to their fields?') is operationalized by raising one additional subquestion: (2.1) 'What is the role of school success (GPA) in the actualization of mathematical giftedness?'

### *School success*

Both the Finnish and US (Campbell 1996b) Olympians were all very successful at school. Most of them ranked at least in the top ten among graduates of their high school class and over sixty per cent in both countries (Finland 62.5 per cent; US 62.1 per cent) were in the top three in their class. Olympians' Scholastic Aptitude Test (SAT) scores were also exceptionally high in both data sets (Table 8).

An Emulated Scholastic Aptitude Test in the Finnish data was calculated from grade point averages and matriculation examination results by applying the following formula:

1 + ((size / rank) / 100 ) * top_ten
size = number of graduates [1, … , n]
rank = ranking by school success [1, … , n]
top_ten = top ten percent [3 = best, 2 = second best, 1 = in top ten, 0 = no value]

Table 8. Olympians in Finnish and US High Schools

| | Finland | US |
|---|---|---|
| *Rank in graduation class (%)* | | |
| $1^{st}$ | 45.8 | 24.3 |
| $2^{nd}$ | 6.9 | 5.4 |
| $3^{rd}$ | 9.7 | 32.4 |
| *Grades in high school (Scale: highest 7; lowest 1)* | | |
| Math | 6.93 | 6.99 |
| Science | 6.79 | 6.90 |
| Native language | 6.14 | 6.50 |
| Social studies | 6.28 | 6.40 |

The academic success of the Finnish Olympians continued in their studies at universities. They reported that the transition to university studies was very easy (4.5 on a scale of 5). However, only 12 per cent of the Olympians had had a chance to participate in a special program or individualized opportunities at their universities. The Olympians remained very independent in their studies; less than half (40 per cent) of them reported having mentors to aid their development. Compared to the US sample, the Finnish Olympians found the transition to university easier than did their US colleagues, and they had been provided fewer special programs and individualized opportunities as well as less mentoring during their university studies (see Campbell 1996b for the US results).

*Productivity*

Measures of productivity discussed here involve enrollment in colleges, completion of college/university degrees and academic productivity (including articles, books and patents published and research papers presented). The Olympians were successful in enrolling in the most selective colleges/universities in the US and Finland. Eighty-six per cent of Finnish Math Olympians completed their undergraduate degrees; the analogous figure in the US data is a full 100 per cent. Thirty-one US (42 per cent) and 29 (47 per cent) Finnish Olympians completed their Ph.D. or law degrees. Table 9 shows academic productivity among the US and Finnish Olympians in the form of publications and patents. It must be emphasized when comparing academic productivity that US Olympians are far younger than Finns and are therefore expected to publish later in their career.

Table 9 indicates that the typically American cultural habit of team work or mentoring is not very popular in Finland; only six Finnish Math Olympians were mentored. Perhaps the effect of the sophisticated US mentoring culture is seen in the results that prove mentored Americans more productive than non-mentored in all productive areas. The same direction is observable, too, with Finnish Olympians, but with smaller differences.

Table 9. Finnish and US Olympians' Academic Productivity

| | Finland | | | US | | |
|---|---|---|---|---|---|---|
| | Mentored Olympians (N=6) [M] | Non-mentored Olympians (N=57) [M] | Total (N=63) [M] | Mentored Olympians (N=46) [M] | Non-mentored Olympians (N=27) [M] | Total (N=73) [M] |
| *Academic productivity* | | | | | | |
| Articles published | 61 [10.2] | 374 [6.6] | 435 [6.9] | 401 [8.7] | 34 [1.3] | 435 [5.9] |
| Books published | 12 [2] | 57 [1] | 69 [1.1] | 14 [0.3] | 1 [0.0] | 15 [0.2] |
| Research papers presented | 70 [11.7] | 494 [8.7] | 569 [9.0] | 252 [5.5] | 22 [0.8] | 274 [3.8] |
| Patents | 3 [0.5] | 5 [0.1] | 8 [0.1] | 12 [0.3] | 3 [0.1] | 15 [0.2] |

## Path analysis—productivity

The second research question ('Do the Olympians fulfill their potential by making contributions to their fields?') was broken down into a series of separate questions that were answered under the previous two headings. The dependent variable in multivariate path analysis was productivity together with eleven predictor variables. The following predictor variables were used in the path analysis: mentoring (Table 9); computer literacy factor (Table 6); two school hindrance factors, one from Olympians' and one from parents' perspective (Table 2); GPA (Table 8); effort and ability attributions factors (Table 5); positive home influence factors including parents' factors of support, help, press for intellectual development and conducive home atmosphere (Table 3), negative home influence factor including parents' factors of pressure and monitoring (Table 4), age (Table 1) and socioeconomic factor including parents' occupational status, educational levels and the family's income.

Results of the path analysis show that only one of the US Olympians' variables (age) and five of the Finnish Olympians' variables (both school hindrance factors, effort attribution, negative home influence, age) had significant path coefficients with the productivity variable (Table 10). In both the Finnish and the US data sets, a significant positive influence of age and productivity proved that mature Olympians wrote the most articles, books and research papers. Campbell (1996b) reports that when age is eliminated from the analysis in the US data, mentoring emerges as a significant influence (0.22) on productivity.

Table 10 shows that effort attribution is an important predictor for academic productivity (Finnish: 0.44*, $p < 0.05$ and US: 0.17). Computer literacy was negatively related to productivity in the US data (–0.16) and quite strongly positively related in the Finnish data (0.26). The difference is explained by the fact that US

Table 10. Academic productivity—path coefficients and correlations

| Dependent variable | Predictor variables | Direct effect (Finnish) | Direct effect (US) | Indirect effect (Finnish) | Indirect effect (US) | Total effect (Finnish) | Total effect (US) | r with Productivity (Finnish) | r with Productivity (US) |
|---|---|---|---|---|---|---|---|---|---|
| | | Finnish (US) mathematicians | | | | | | | |
| *Productivity* | | | | | | | | | |
| | Mentor | 0.23 | (0.07) | — | (—) | 0.23 | (0.07) | 0.09 | (0.32) |
| | Computer literacy | 0.26 | (–0.16) | –0.02 | (0.01) | 0.24 | (–0.15) | 0.12 | (–0.11) |
| | School hindrance (Olympians) | 0.31* | (–0.03) | –0.30* | (0.01) | 0.01 | (–0.02) | –0.22 | (–0.19) |
| | School hindrance (Parents) | 0.79* | (–0.09) | –0.45* | (0.00) | 0.34* | (–0.09) | –0.20 | (–0.19) |
| | GPA | 0.10 | (–0.03) | — | (—) | 0.10 | (–0.03) | 0.20 | (0.03) |
| | Effort attribution | 0.44* | (0.17) | 0.00 | (0.01) | 0.44* | (0.18) | 0.29 | (0.16) |
| | Ability attribution | –0.11 | (0.01) | — | (—) | –0.11 | (0.01) | –0.09 | (0.17) |
| | Positive home influence | 0.08 | (0.02) | 0.02 | (0.03) | 0.10 | (0.05) | –0.03 | (0.05) |
| | Negative home influence | –0.36* | (–0.09) | 0.06 | (0.02) | –0.30 | (–0.07) | –0.14 | (–0.20) |
| | Age | 0.52* | (0.51*) | 0.07 | (0.02) | 0.59* | (0.53*) | 0.55 | (0.52) |
| | SES | –0.08 | (0.13) | 0.13 | (0.00) | 0.05 | (0.13) | –0.35 | (0.07) |

*$p < 0.05$ $R^2 = 0.27$ (0.38)

computer literate individuals are employed outside academia (Campbell, 1996b), but most Finnish Olympians have chosen academic careers (Tirri, 2001).

Olympians' SES had a significant positive influence on productivity in US Olympians (Table 10), but it did not have a mentionable effect in the Finnish data. It should be noted that GPA was not found to be an important variable for productivity. This observation is supported by two facts: (1) high dependency of age and productivity (Finnish: 0.52* and US:0.51*, $p < 0.05$), and (2) biased age distribution (see Table 1), which leads us to conclusion that at the time of this study the Olympians were still 'mainly knowledge consumers rather than knowledge producers' (Wu & Chen, 2001, p. 22).

## Discussion

In this paper we have discussed cross-cultural factors that predict mathematical talent and academic productivity in adulthood. Our sample included 152 Olympians from the United States and Finland. This group represents the most highly performing high school students in mathematics in both countries. The empirical findings reported in this paper indicate that the Finnish Olympians actualize their mathematical talent by choosing a career in science. The majority of them are researchers in academia or engineers in technical fields. US Olympians choose more business-oriented work places. The Olympians in both countries have been very successful in

their graduate studies, and they have published numerous articles and books related to their fields.

Computer literacy of the Finnish Olympians predicts both their school success and academic productivity. The results show that the amount of culture dependent factors (computer literacy) is less than the amount of culture invariant factors (school hindrances, effort attributions, negative home influences) that contribute to the development of the Mathematic Olympians' talent. Finally, the results of path analysis suggest that the high school grade point averages is a slight positive (Finnish) or negative (US) predictor of academic productivity in Olympians' careers. The overall results of path analysis indicated that positive support of school and family are both very important factors that enable Olympians to use their full potential. Cross-cultural differences are clearly indicated by the fact that neither of the original US path models fit satisfactorily into the Finnish data (GPA: 0.15 / 0.23; Productivity: 0.27 / 0.38). In the ongoing research work, we are applying Bayesian techniques to solve modeling problems related to this issue of cultural-specific model selection.

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