Scoring Above the International Average: A Logistic Regression Model of the TIMSS Advanced Mathematics Exam

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This study examined 2349 advanced mathematics students from the Third International Mathematics and Science Study. Students were separated into two groups: those that scored above the international average of 501 and those who scored below. Logistic regression was then utilized to model the student data. Results indicate that students whose parents had less than a high school education were one-fourth as likely to score above the international average and students who were enrolled in advanced mathematics and physics courses were three times as likely to score above the international. A probability model is also discussed.

The intense concern over the mathematics achievement levels of U. S. elementary and high-school students can be seen through the number of articles published (Baker, 1993a, 1993b; Bracey, 1991, 1992, 1993; Freudenthal, 1975, Rotberg, 1990; Stedman, 1994a, 1994b). A great deal of debate has centered on the fact that the U.S. scored lower than many countries on most of the assessments. Very little discussion has focused on U.S. high school seniors and on the simultaneous examination of factors that are associated with scoring above the international mean. The questions, which motivate this study, are: What student variables are associated with scoring above the international mean on the TIMSS advanced mathematics test? How much of an impact do these variables have?

Theoretical Framework

Over the past few decades a great deal of research has been conducted on the student level factors that impact mathematics achievement. The positive relationship between attitude (ATT) and achievement (ACH) has long been observed (Ethington & Wolfe, 1984, 1986; Lester, Garafalo, & Kroll, 1989; Ma, 1997; Suydam & Weaver, 1975). Ma and Kishnor (1997) conducted a meta-analysis concerning the effect of mathematical self-concept and achievement in mathematics (ACH) and found a significant effect size of .23 (statistically different than zero) for self-concept about mathematics and ACH. The authors concluded that a positive self-concept about mathematics is associated with higher achievement in mathematics. Ma (1997) observed that attitudes towards mathematics (e.g., importance, difficulty, enjoyment) influenced achievement. As crucial as attitude towards mathematics is for mathematics achievement, understanding a student's academic related beliefs is also an important key to comprehending the student's achievement level (Dweck, & Elliot, 1983; Felson, 1984). Academic beliefs have been observed to impact the achievement level of students (Dweck & Elliot, 1983) and Schoenfeld (1985) has pointed out that students' beliefs about mathematics may impede their ability to solve problems.

Extracurricular activities (EA) for students have been glorified and chastised over the years (Gerber, 1996). Two main of views of EA exist. The first view is that extracurricular activity is similar to a zero sum game where greater activity will subvert academic achievement (Coleman, 1961; Marsh, 1992). The second view is that EA experiences "further the total development of the students," thereby enhancing non-academic goals and possibly facilitating academic goals (Holland & Andre, 1987; Marsh, 1992).

A common extracurricular activity is athletics (e.g., football, softball, baseball, soccer). A review of research by Holland and Andre (1987) focused on the examination of the relationship between athletic participation and achievement. They reported that the research demonstrated that male high school athletes received somewhat higher grade-point averages (GPA's) than did non-athletes. When one considers standardized achievement or aptitude tests, males, whose only after school activity is sports, scored lower than the national average on the Standardized Achievement Test. No significant difference in either grade-point average or standardized test scores was observed between female athletes and non-athletes.

The influence of part time employment, another common after school activity for American high school students, on achievement has shown mixed results in the research literature. Some studies indicate that part-time employment has a negative influence on achievement (e.g., Brown & Steinberg, 1991; Cooper et al., 1999); whereas, other studies show a positive influence (D'Amico, 1984), or no influence (Green & Jacquess, 1987). Cooper et al. (1999) reported that the number of hours per week had a significant inverse association with standardized test scores (r=-.29) and with teacher assigned grades (r=-.17). With 51.6% of high school senior female students and 47.5 percent of high school senior male students working, the examination of the effects of employment on achievement is critical (Green, Dugoni, Ingels, & Camburn, 1995).

With regard to homework, Cooper (1989) observed a positive linear relationship between hours per week spent on homework (0 to 10 hours) and achievement. Television has traditionally been assumed to lessen achievement (Comstock, 1991; Keith et al., 1986). Simply, television viewing displaces academic activities and reduces the amount of time available for completing homework and other academic activities, thereby reducing achievement. Keith et al. (1986) observed a small but negative relationship between the amount of television watched and achievement. In a review of research, Williams, Haertel, Haertel, and Walberg (1982) observed a strong negative effect after ten hours per week. The negative effect increases and is extreme after thirty hours per week. A more recent study by Cooper et al. (1999) observed a significant negative association between achievement and television viewing (mean viewing was 1-2 hours per night).

Differences in mathematics achievement for male and female students have been observed (Anderson, 1989; Sherman, 1987). Currently there is still debate about the observed differences. Some researchers have observed a large difference (Benbow & Stanley, 1980) and some no difference (Radhawa, Beamer, & Lundberg 1993). The more consistent finding in the research appears to be that some differences still exist but not in all areas of mathematics (Fennema & Carpenter, 1981).

Finally, numerous research articles have been written concerning family background variables such as parental socio-economic status (SES) or parent education (Keith & Cool, 1992; Lockheed & Komenan, 1989; McConeghy, 1987; Santiago & Okley, 1992). The positive relationship between parental SES or parent education level and achievement has been consistently observed (Goleman, 1988; Heyns, 1978). Similar results for SES have been observed in multilevel modeling (Lee & Bryk, 1989).

Methodology

Sample

The sample for this study consists of U.S. students from the Third International Mathematics and Science Study (TIMSS) Population 3 final year of secondary school cohort (High School Seniors) who were administered the advanced mathematics test. All students who were administered the advanced mathematics instrument were designated advanced mathematics students or advanced mathematics and physics students. Total sample size is 2349 with 1158 girls and 1191 boys.

Variables

A listing of each variable, TIMSS label, and coding information is provided in Appendix A. The dichotomous outcome variable is based on the first plausible value of the advanced mathematics test. Students who scored over the international average of 501 were coded as one, and students who scored below the international average were coded as zero. Though dichotomizing typically reduces statistical power, with all the variables being statistically significant in the logistic regression model this concern is reduced. Scoring above the international average is not the primary goal of mathematics education in the United States, just a component of this study. The justification for this dichotomous split is due to the fact many of the articles concerning international data discuss those who score above and below the international average (e.g., Carson, Heulkamp, & Woodall, 1993, Garden, 1989; Mullis, Martin, Beaton, Gonzales, Kelly, & Smith, 1998) but do not discuss in detail the combination of factors that are associated with this separation. Secondly, the author was interested in creating a probability model, which is possible with logistic regression.

Table 1. Frequency Tabulations of Dichotomous Variables

Variable	Below International Average	Above International Average
Gender		
Boy (0)	816	375
Girl (1)	918	240
Advanced Math/Physics		
Advanced Math (0)	914	150
Advanced Math and Physics (1)	820	465
[a]Parent Education 1 (High School)		
No = 0	840	458
Yes = 1	753	135
Parent Education 2 (Elem. School)		
No = 0	1446	573
Yes = 1	147	20

Note: *a*. 1131 students had parents who graduated from a university, 888 from high school, 167 only elementary school.

Table 2. Descriptive Statistics for Continuous Variables

Variable	Below International Average	Above International Average
Attitude	10.53	8.89
	(2.94)	(2.45)
Natural Talent	2.47	2.20
	(0.75)	(0.76)
Hard Work	1.58	1.86
	(0.66)	(0.78)
Television	2.76	2.58
	(0.96)	(0.94)
Employment	2.66	2.20
	(1.68)	(1.46)
Sports	2.36	2.28
	(1.21)	(1.14)
Studying Math	2.14	2.26
	(0.79)	(0.73

Note. Standard Deviations (SD) are in parantheses.

The independent variables are categorized into three areas:

Background of Student consisted of: Parent Education (dummy coded), Gender (Girls), and Advanced Math/Physics;

After School Time consisted of: Television Viewing, Employment, Sports, and Studying Math;

Affective Factor was composed of: Attitude, Natural Talent Belief, Hard Work Belief.

Analysis

To answer the research questions posed, a logistic regression analysis was conducted and the variables of interest were run in blocks. The first block contained background variables: Parent Education, Gender (Girls), Math/Physics Expert. The second block contained the first block and affective factors: Attitude, Natural Talent, Hard Work. The final block included the previous two blocks and after school time variables: Television, Employment, Sports, Studying Math.

Results

Tables 1 and 2 provide descriptive statistics of the variables of interest separated by scoring above or below the international average. Table 3 provides results from the from the logistic regression analysis. Block 1 results indicate that parental education, gender (girls) and advanced mathematics and physics were significantly related to scoring above international mean. Taking the exponential of the coefficient for advanced mathematics and physics ($e^{1.105}$) provides an odds ratio of 3.019, which indicates that students enrolled in advanced mathematics and physics were three times as likely to score above the international average than students only enrolled in advanced mathematics. Students whose parents had only completed elementary school ($e^{-1.368}$) were only one-fourth as likely to score above the international mean. The Hosmer and Lemeshow statistic indicates that the model was a good fit. The Cox and Snell and Nagelkerke R^2 values indicate less than 20 percent of the “variance” or likelihood was accounted with the Block 1 variables. These values are analogous to the traditional R^2 in multiple regression, but are specific to logistic regression due to the dichotomous dependent variable.

Table 3. Logistic Regression Results for the Three Blocks

	Block 1			Block 2			Block 3		
Factor	*b*	*SE*	*p*	*b*	*SE*	*p*	*b*	*SE*	*p*
High School	-1.17	0.17	<.001	-1.31	0.12	<.001	-1.25	0.12	<.001
Elem. School	-1.36	0.25	<.001	-1.69	0.28	<.001	-1.75	0.28	<.001
Gender (Girl)	-0.37	0.10	<.001	-0.20	0.11	.063	-0.39	0.12	.001
Advanced Math & Physics	1.10	0.11	<.001	0.97	0.12	<.001	0.91	0.12	<.001
Attitude				-0.26	0.02	<.001	-0.25	0.02	<.001
Natural Talent				-0.45	0.08	<.001	-0.45	0.08	<.001
Hard Work				0.39	0.08	<.001	0.49	0.08	<.001
Televsions							-0.16	0.06	.006
Job							-0.17	0.05	<.001
Sports							-0.16	0.04	.001
Math Study							0.27	0.08	.001
-2log likelihood	2260.85			2007.13			1938.44		
Hosmer-Lemeshow χ^2	5.82 *df* = 6			8.66 *df* = 8			5.968 *df* = 8		
Cox & Snell R^2	.126			.214			.231		
Nagelkerke R^2	.183			.309			.335		

The results from the Block 2 analysis indicate that all the variables, except Gender, were significantly related to scoring above the international mean. This indicated the possibility of an interaction between Gender and the affective variables (Edward St. John, Personal Communication). Since the interaction of affective variables and gender are well documented (McLeod, 1992), intermediate models were run (see Table 4) to examine the association of interactions on the model (Gender*Attitude, Gender*HardWork, Gender*Natural Talent). The interactions were not significant, the –2log likelihood did not significantly change, and the R^2 estimates were not significantly altered. According to Hosmer and Lemeshow (1989) this indicates that affect may be a confounder but not an effect mediator.

Also, after including affect variables – in essence statistically controlling for the association of affect – changes in the negative association of formal parent education changes were evident. The coefficients for both variables increased. The impact of being enrolled in advanced mathematics and physics had a decrease in association from Block 1 to Block 2. For the continuous variable Attitude, the results indicate the worse the students attitude the less likely the student scored over the international average. The coefficient for Natural Talent indicates that the more a student believed that natural talent was a key to mathematics success the more likely the student scored above the international average. Finally, the less a student believed in hard work as a key to mathematics success the more likely the student scored over the international average.

The –2 log likelihood value dropped from Block 1 to Block 2 and the Hosmer-Lemeshow statistic indicates that the Block 2 model is a better fit for the data. Finally, The R^2 estimates indicate more “variance” was accounted for by the inclusion of the Affect variables, which was expected.

Block 3 results indicate that the variables from Blocks 1 and 2 and the new variables are significantly associated with scoring above the international mean. Taking the exponential of the Studying Math coefficient ($e^{.27}$) shows that for every one unit increase on the scale the odds of scoring above the international average increases by 1.3. Television viewing, employment and sports participation decreased the likelihood of scoring above the international mean. For example, for every unit increase in sports participation the probability of scoring over the international average decreases by a factor of 0.85 ($e^{-.16}$). In essence decreasing the probability of scoring over the international average.

Table 4. Examination of Gender and Affect Interaction

Interaction	*b*	*SE*	-2Log Likelihood	Cox & Snell R^2	Nagelkerke R^2
Gender*Attitude	0.03	0.04	2006.66	.214	.310
Gender*Natural Talent	-0.17	0.15	2005.79	.214	.310
Gender* Hard Work	-0.18	0.16	2005.82	.214	.310

Table 5. Interaction Effects of Gender by Extracurricular Activity.

Interaction	*b*	*SE*	-2Log Likelihood	Cox & Snell R^2	Nagelkerke R^2
Gender*Television	0.002	0.112	1938.44	0.231	0.335
Gender*Job	0.050	0.073	1937.97	0.233	0.331
Gender*Sports	0.223	0.336	1937.32	0.232	0.336
Gender*Studying	0.028	0.154	1938.41	0.231	0.335

From Block 2 to Block 3 the variable Gender went from not significant to significant indicating a possible interaction with extracurricular activities. Therefore, these interactions (Gender*Television, Gender*Employment, Gender*Sports, Gender*Studying Math) were examined. None of the interactions were significant and the interactions did not significantly change the –2log likelihood or the R^2 values (see Table 5).

Though mostly completed with epidemiological research, a probability equation can be developed to examine a student's probability of scoring above the international average. The equation is:

$$\pi(X) = \exp(A)/[1+\exp(A)], \text{ where}$$
$$A = 2.483 - 1.252(\text{HS}) - 1.756(\text{ES}) - .392(\text{Girls}) + .913(\text{AMP}) - .256(\text{Att}) - .457(\text{NT}) + .499(\text{HW}) - .166(\text{TV}) - .163(\text{Sports}) - .172(\text{Job}) + .272(\text{MStdy}).$$

A boy whose parents graduated from college, is not enrolled in advanced mathematics and physics, has a good attitude towards mathematics and average score on beliefs, watches TV, works, plays sports and studies a couple of hours per day, would have a value of 0.48 indicating a 48 percent probability of scoring above the international average. Keeping everything the same except making the student enrolled in both advanced mathematics and physics increases the value to .74. Using an equation such as this, though, is only useful when the variables can be controlled, such as working and studying.

Discussion

With the publication of the international scores and the discussion about the rank of American students average score it was important to look at factors that were associated with scoring above the international mean. The advanced mathematics and advanced mathematics and physics students were chosen because there has been less emphasis on their performance. By using such a unique group of students it was hoped by the author that traditional variables would not have a strong impact on scoring above or below the international average. Unfortunately, formal parent education level and gender were significantly associated with scoring above the international mean showing that this traditionally observed disparity still exists. This indicates that there is still a great deal of work to be done to close this gap. The results indicate a more in-depth examination of this is needed. For example, a study of classrooms of advanced mathematics students with varying levels of SES and gender followed for a specified time period may help to understand the factors associated with these disparities.

The result for advanced mathematics and physics students was expected. Students who are concurrently enrolled in mathematics and physics courses see many of the same equations and solve many of the same types of problems. The dual coverage of content, amount of time with the material, and similar activities in the courses provides the students more opportunity to learn the content. Therefore, advanced mathematics and physics students are potentially spending twice as much time during each day with advanced mathematics problems. Another aspect that may be influencing the difference is an abstract to concrete representation of the material (Danesi, 1993). A great deal of work completed in advanced mathematics courses may appear to students to be abstract. In the physics courses those students may be seeing concrete representations of the abstract ideas from their mathematics course. The connection may have assisted the students who are enrolled in both course score above the international average. But this too needs to be researched further to examine if this could be contributing to the observed difference or something else, such as students who are concurrently enrolled in both courses have more "ability" or a higher "IQ."

The affective factors, though important to understand and monitor are difficult to change. Being a former mathematics instructor, the author understands the difficulty in attempting to change attitudes and beliefs that have developed over many years. More importantly, though, the results demonstrate that our most advanced students are impacted in a similar way as the rest of our mathematics students (Schreiber, 2000). With regard to beliefs, the data indicate that (due to reverse coding) those students who believe that success in mathematics is due to natural talent were more likely to score above the international mean. This is in contrast to work by Dweck (1986) and Schommer (1990). Traditionally those students who have believe that ability or intelligence is fixed tend to perform lower and not persist in difficult tasks (Dweck, 1986) or, avoid difficult tasks if they think their ability is low (Dweck, 1986). Further, Schommer (1990) observed that students who believe success is tied to natural talent or ability tend to do worse academically. One explanation for this observation is the uniqueness of the cohort and the may not have experience much failure in the mathematics domain. This may be part of the reason for the development of this belief. Recently, Dai, Moon, and Feldhusen (1998) observed that gifted and talented students that have high levels of self-efficacy attribute success to both high ability and hard work. Overall, affective factors are associated with performance and need to be considered.

Time variables, overall, may be more readily modified than affective factors. Their association is smaller in the model than other variables, but still significant. As students engage in more hours per day in these activities they may positively (studying) or negatively (TV, job, sports) impact performance. Scoring above the international average in this study is associated with less time in non-academic activities and more time studying. The issue is not to remove these activities because they do provide a great deal of societally beneficial effects (time management, responsibility, working as a group, school retention), but to monitor the amount of time and energy these activities are absorbing. Even within these observations, more in-depth research needs to be conducted on the effects of different types of activities (e.g., school/non school, academic/non-academic, organized/unorganized) on achievement.

In addition to the importance of the findings, this study also demonstrates that logistic regression can be a useful tool in modeling educational data because it allows for the examination of factors related to academic achievement based on a criterion cut off point. Finally, the reader is reminded that these data are from a very select group of students and only one model or view of the factors associated with advanced mathematics achievement was examined, therefore, these results should be weighed with previous observations and other research findings.

References

Anderson, J. (1989). Sex related differences on objective tests among undergraduates. *Educational Studies in Mathematics, 20,* 165-177.

Baker, D. P. (1993a). Compared to Japan, the U.S. is a low achiever really: New evidence and comment on Westbury. *Educational Researcher, 22 (*3), 18-20.

Baker, D. P. (1993b). A rejoinder. *Educational Researcher, 22 (*3), 25-26.

Benbow, C. P., and Stanley, J. C. (1980). Sex differences in mathematical ability: Fact of artifact? *Science, 12,* 1262-1264.

Bracey, G. W. (1991). Why can't they be like we were? *Phi Delta Kappan, October,* 105-117.

Bracey, G. W. (1992). The second Bracey report on the condition of public education. *Phi Delta Kappan, 74,* 104-117.

Bracey, G. W. (1993). The third Bracey report on the condition of education. *Phi Delta Kappan, 75,* 105-117.

Brown, B. B., & Steinberg, L. (1991). *Noninstructional influences on adolescent engagement and achievement. Final Report Project 2.* Madison, WI: National Center on Effective Secondary Schools. (ERIC Document Reproduction No. ED340641).

Carson, C. C., Heulskamp, R. M., & Woodall, R. D. (1993). Perspectives on education in American. *The Journal of Educational Research, 86,* 259-310.

Coleman, J. S. (1961). *The adolescent society,* New York, NY: Free Press of Glencoe.

Comstock, G. (1991). *Television and the American child.* New York: Academic Press.

Cooper, H. (1989). *Homework*. New York: Longman.

Cooper, H., Valentine, J. C., Nye, B., & Lindsay, J. J. (1999). Relationships between five after-school activities and academic achievement. *Journal of Educational Psychology, 91* (2), 369-378.

Dai, Y. D., Sidney, M. M., & Feldhusen, J. F. (1998). Achievement motivation and gifted students: A social cognitive perspective. *Educational Psychologist, 33* (2/3), 45-63.

D'Amico, R. (1984). Does employment during high school impair academic progress? *Sociology of Education, 57,* 152-164.

Danesi, M. (1993). Messages and meaning: An Introduction to semiotics. Toronto, ON: Canadian Scholar's Press.

Dweck, C. S. (1986). Motivational processes affecting learning. *American Psychologist, 41* (10), 1040-1048.

Dweck, C. S., & Elliot, E. S. (1983). Achievement motivation. In E. M. Hetherington (Ed.), P. H. Mussen (Series Ed.), *Handbook of child psychology: Vol. 3. Socialization, personality, and social development, 4th ed,* (643-691). New York, NY: Wiley.

Ethington, C. A., & Wolfe, L. M. (1984). Sex differences in a causal model of mathematics achievement. *Journal for Research in Mathematics Education, 15,* 361-377.

Ethington, C. A., & Wolfe, L. M. (1986). A structural model of mathematics achievement for men and women. *American Educational Research Journal, 23,* 65-75.

Felson, R. B. (1984). The effect of self-appraisal of ability on academic performance. *Journal of Personality and Social Psychology, 47,* 944-952.

Fennema, E., & Carpenter, T. P. (1981). Sex related differences in mathematics: Results from a national assessment. *Mathematics Teacher, 74,* 554-559.

Freudenthal, H. (1975). Pupil's achievement internationally compared—The IEA. *Educational Studies in Mathematics, 6,* 127-186.

Garden, R. A. (1989). Students' achievements: Population be. In D. F. Robitaile and R. A. Garden (Eds.), *The IEA study of mathematics II: Contexts and Outcomes of School Mathematics.* (126-152). New York: Pergamon Press.

Gerber, S. B. (1996). Extracurricular activities and academic achievement. *Journal of Research and Development in Education, 30* (1), 42-50.

Goleman, D. (1988, April 10). An emerging theory on blacks' I.Q. scores. *New York Times* (Education Life Section), 22-24.

Green, G., & Jacquess, S. N. (1987). The effect of part-time employment on academic achievement. *Journal of Educational Research, 80,* 325-329.

Green, P. J., Dugoni, B. L. Ingels, S. J., & Camburn, E. (1995). *A profile of the American high school senior in 1992. National Educational Longitudinal Study of 1988. Statistical Analysis Report.* National Opinion Research Center. (ERIC Document No. ED 386 502)

Heyns, B. (1978). *Summer learning and the effects of schooling.* New York: Academic Press.

Holland, A., & Andre, T. (1987). Participation in extracurricular activities in secondary school: What is known, what needs to be known? *Review of Educational Research, 57,* 437-466.

Keith, T. Z., Reimers, T.M., Fehrman, P.G., Pottebaum, S.M., & Aubey, P.G. (1986). Parental involvement in homework and TV time: Direct and indirect effects on high school achievement. *Journal of Educational Psychology, 78,* 373-380.

Keith, T.Z. & Cool, V. A. (1992), Testing models of school learning: Effects of quality of instruction, motivation, academic coursework, and homework on academic achievement. *School Psychology Quarterly, 7 (3),* 207-226.

Lee, V. E., & Bryk, A. S. (1989). A multilevel model of the distribution high school achievement. *Sociology of Education, 62* (3), 172-192.

Lester, F. K., Garofalo, J., & Kroll, D. L. (1989). Self-confidence, interest, belief, and metacognition: Key influences on problem-solving behavior. In D. B. McLeod & V.M. Adams (Eds.), *Affect and mathematical problem solving: A new perspective* (75-88). New York: Springer-Verlag.

Lockheed, M.E. and Komenan, A. (1989). Teaching quality and student achievement in Africa: The case of Nigeria and Swaziland. *Teacher and Teacher Education, 5 (2),* 93-113.

Ma, X. (1997). Reciprocal relationships between attitude toward mathematics and achievement in mathematics. *The Journal of Educational Research, 90* (4), 221-229.

Ma, X., & Kishnor, N. (1997). Attitude toward self, social factors, and achievement in mathematics: A meta-analytic review. *Educational Psychology Review, 9 (*2), 89-120.

Marsh, H. W. (1992). Extracurricular activities: Beneficial extension of the traditional curriculum or subversion of academic goals? *Journal of Educational Psychology, 84* (4), 553-562.

McConeghy, J. I. (1987). Mathematics attitudes and achievement: Gender differences in a multivariate context. ERIC Services Document 284742.

McLeod, D. B. (1992). Research on affect in mathematics education : A reconceptualization. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 575-596). New York : Macmillan.

Mullis, I. V. S., Martin, M. O., Beaton, A. E., Gonzales, E. J., Kelly, D. L., & Smith, T. A. (1998). *Mathematics and Science Achievement in the Final Year of Secondary School.* Chestnut Hill, MA: Boston College.

Radhawa, B. S., Beamer, J. E. & Ingvar, L. (1993). Role of mathematics self-efficacy in the structural model of mathematics achievement. *Journal of Educational Psychology, 85* (1), 41-48.

Rotberg, I. (1990). I never promised you first place. *Phi Delta Kappan, 72,* 296-303.

Santiago, R. W., & Okley, J.R. (1992). The effects of advisement and locus of control on achievement in learner controlled instruction. *Journal of Computer-Based Instruction 19 (2),* 47-53.

Schoenfeld, A.H. (1985). *Mathematics problem solving.* Orlando, FL: Academic Press.

Schommer, M. (1990). The effects of beliefs about the nature of knowledge on comprehension. *Journal of Educational Psychology*, 82, 498-504.

Schreiber, J. B. (2000, April). *High-school seniors' mathematics literacy*. A poster presented at the annual meeting of the American Educational Research Association, New Orleans.

Sherman, J. (1987). *Sex related cognitive differences*. Springfield, IL: Wiley.

Stedman, L. C. (1994a). The sandia report and U.S. achievement: An assessment. *Journal of Educational Research, 87* (3), 133-146.

Stedman, L. C. (1994b). Incomplete explanations: The case of U.S. Performance in the international assessments of education. *Educational Researcher, 23* (7), 24-32.

Suydam, M. N., & Weaver, J. F. (1975). Research on mathematics learning. In J. N. Payne (Ed.), *Mathematics learning in early childhood: Thirty seventh yearbook* (44-67). Reston, VA: National Council of Teachers of Mathematics.

Williams, P. A., Haertel, E. H., Haertel, G. D., & Walberg, H. J. (1982). The impact of leisure-time television on school learning. *American Educational Research Journal, 19,* (1), 19-50.

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Appendix A

The following variables were either selected from those in the TIMSS Population 3 data set or were developed using other variables from the data set.

1. **Gender**: ITSEX. 1 = Girls; 0 = Boys
2. **Parent Education**: CSDGEDU. This variable was dummy coded into:

	Parent Education 1	Parent Education 2
University Graduate	0	0
High School Graduate	1	0
Primary School Graduate	0	1

3. **Advanced Math/Physics**: IDSUBPOP Recoded 1 = Adv. Math and Physics, 0 = Advanced Math
4. **Attitude** (Composite): CSBENJY, CSBMBORE, CSBMEASY, CSBMLIFE, CSBMLIKE. For each individual variable 1 = strongly agree to 4 = strongly disagree. CSBMBORE and CSBMLIKE were reverse coded to match the direction of the others. The variables were added together to create the composite. The lower the attitude score, the better the attitude towards mathematics in general. Alpha = .8241
5. **Natural Talent**: CSBMDOW1. 1 = strongly to agree 4 = strongly disagree. Those who chose strongly agree indicated that natural talent was the key to mathematics success.
6. **Hard Work**: CSBMDOW3. 1 = strongly agree to 4 = strongly disagree. Those who chose strongly agree indicated that hard work was the key to mathematics success.
7. **Television**: CSBGDAY1. 1 = No time per school day, 2 =Less than one hour per school day, 3 = 1-2 hours per school day, 4 = 3-5 hours per school day, 5 = more than five hours per school day.
8. **Sports**: CSBGDAY6. 1 = No time per school day, 2 = Less than one hour per school day, 3 = 1-2 hours per school day, 4 = 3-5 hours per school day, 5 = more than five hours per school day.
9. **Employment**: CSBGDAY5. 1 = No time per school day, 2 =Less than one hour per school day, 3 = 1-2 hours per school day, 4 = 3-5 hours per school day, 5 = more than five hours per school day.
10. **Studying Math**: CSBGDAY. 8 1 = No time per school day, 2 =Less than one hour per school day, 3= 1-2 hours per school day, 4 = 3-5 hours per school day, 5 = more than five hours per school day.
11. **Television**: CSBGDAY1. 1 = No time per school day, 2 =Less than one hour per school day, 3 = 1-2 hours per school day, 4 = 3-5 hours per school day, 5 = more than five hours per school day.