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AUTHOR Titus, Janet C.; Terwilliger, James S.
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ABSTRACT

A special effort was undertaken in 1988 to increase the number of females in the University of Minnesota Talented Youth Mathematics Program (UMTYMP), a program of accelerated mathematics instruction for elementary school, junior high school, and senior high school students. As part of this effort, attitudinal data were collected from participants. The attitudinal scales that were used are described. Gender differences and attitudinal changes during the students' first year in the program (from the fall of 1988 to the spring of 1989) were studied. Seven attitude scales were developed to measure: (1) interest; (2) motivation; (3) confidence; (4) readiness for taking the mathematics course; (5) support; (6) priorities; and (7) stereotyped attitudes. Subjects were 62 males and 29 females. Mean gender differences for data from the fall tended to favor males on five of the seven scales However, the only significant differences were that males were more confident than females and females were more ready for independent study. Over the year, both sexes exhibited a negative change in attitude. Implications for selection of female students who would be good risks for continuing in the UMTYMP are discussed. Five tables present study data, and the attitude survey is provided in Appendix A. (SLD)

Gender Differences in Attitudes, Aptitude, and Achievement in a Program for Mathematically Talented Youth

Janet C. Titus
and
James S. Terwilliger

Department of Educational Psychology
University of Minnesota

Paper presented as part of a poster symposium on Gender and Mathematics at annual AERA meetings, Boston, MA, April, 1990.

Background

The University of Minnesota Talented Youth Mathematics Program (UMTYMP) was initiated in 1980 to provide a special program of accelerated mathematics instruction for elementary, junior and senior high school students who have been identified as mathematically gifted. Since the inception of the UMTYMP a disproportionate number of males has constituted both the applicant pool (about 60%) and the successful applicants (about 70%). In addition, the first-year attrition rate for females in the program has consistently been higher than that for males despite the fact that classroom performance of the two groups has been comparable.

With support from a grant from the Bush Foundation a special effort was undertaken in 1988 to increase the number of females in the UMTYMP and to decrease the attrition rate for females in the program.. As one part of the effort a decision was made to collect attitudinal data from applicants to the UMTYMP. This paper describes the attitudinal scales which were employed and presents the findings on initial gender differences as well as attitudinal changes which occurred over the first year in the program.

Attitude Survey Form

Attitude Dimensions Measured

Based upon conversations with the UMTYMP staff members and project consultants, seven attitude scales were developed. A brief description of each scale and the rationale for its inclusion are given below.

1. Interest -- One likely contributing factor for student participation in the program is interest in the material. That is, the students themselves must have a desire to participate; they cannot be doing this for anyone else. Items on the Interest scale are designed to tap the students' desire to participate, and include such items as, "I really want to get into a special accelerated math class." and "I feel like I'm being pushed to participate in the University of Minnesota accelerated math class."

2. Motivation -- Because the program is of a high-intensity content, students must have or be willing to develop a motivated, perseverant ("stick with it") nature. The material covered in one two-hour UMTYMP math class is approximately equivalent to two and one-half weeks of content in a regular math class. Thus, students must be motivated to work hard and keep trying, as well as persevere through the demanding pace and work load. Examples of items on the scale include: "I am a hard worker when it comes to solving difficult math problems." and "When a math problem gets too tough for me, I stop trying."

3. Confidence -- Based on anecdotal evidence from the project coordinators, a number of students drop from the program because they believe they "can't do it". That is, they believe they are unable to successfully participate in the program despite the fact that their grades show otherwise. Non-anecdotally, research indicates one's confidence in learning mathematics can influence both achievement and one's decision to participate/not participate in mathematics classes (Chipman & Wilson, 1985). Thus, the Confidence scale intends to tap one's perceived ability to participate successfully in an advanced math class, and includes items such as, "I think I could handle more advanced mathematics."

and "I am afraid I wouldn't do a good job in an advanced math class." The items on the scale are based upon a number of those employed by Fennema and Sherman (1976).

4. Readiness -- Are students mature enough to cope with the demands of a high-intensity math course? As mentioned above, the amount of content covered in one weekly UMTYMP math class, when compared to that amount covered in a regular junior high math class, is extremely demanding. Thus, topics related to the students' personal readiness are assessed here. They include willingness to work independently, willingness/ability to ask for help, and time-budgeting habits with respect to completing homework. Examples of items include: "It doesn't bother me to work on my math homework by myself." and "Even when I have a lot of homework, I usually do it at the last minute."

5. Support — Armstrong (1980) found that the positive influence of significant others is one of the top three variables responsible for students' participation in mathematics. Indeed, the UMTYMP project coordinators believe the social support - or lack thereof - the UMTYMP students receive from important others may be partly responsible for their continuation/non-continuation in the program, more so for the girls than for the boys. Thus, the Support scale is intended to tap encouragement from important others: parents, teachers, and peers. It includes items such as, "My friends will be happy for me if I take an advanced math class." and "My parent(s) really don't care whether or not I get into an advanced math class."

6. Priorities -- Because the UMTYMP is a high-intensity program which requires a significant amount of students' time, students are made aware that it would be difficult to be enrolled in the program AND be active in a number of other social and personal events. Thus, students' priorities with respect to the UMTYMP vs. participation in a number of other events are assessed here. Examples of items on the scale include: "I wouldn't mind giving up some of the time I spend with my friends so I could be in an advanced math class." and "Participating in a number of extra-curricular activities is more important to me than participating in an advanced math class."

7. Stereotypes -- Also of interest is the assessment of a perceived negative stereotyping of students who excel in mathematics. What do "other kids" think about students who excel in mathematics? Although research indicates mathematically gifted students are interpersonally effective and socially mature (Haier & Denham, 1976), popular notions may still unfairly label mathematically gifted students in a negative fashion (Haier & Solano, 1976; Weiss, Haier, & Keating, 1974). Examples of items included on the Stereotypes scale include: "Other kids think students in advanced math classes are cool." and "I'm concerned that the kids at my regular school would think I was a nerd if they knew I was in an advanced math class." Note that the Stereotypes scale does <u>not</u> assess a stereotype associated with the sex-role appropriateness of students who excel in mathematics, but perceived peer opinion of accelerated math students in general.

A copy of the UMTYMP Attitude Survey is presented in Appendix A.

Response Format and Scoring

The format for responses to individual items is a five-point Likert scale coded as follows: 5=Strongly Agree, 4=Agree, 3=Neutral, 2=Disagree, and 1=Strongly Disagree. Each of the seven scales consists of six items, three worded positively (e.g., "I have a lot of self-confidence about taking advanced math.") and three worded negatively (e.g., "I am afraid I wouldn't do a good job in an advanced math class."). To obtain a scale score, the coding for the negatively worded items was reversed (1=Strongly Agree, 2=Agree, 3=Neutral, 4=Disagree, and 5=Strongly Disagree) prior to summing the responses to the six items in each scale. Consequently, a student who strongly agrees with all positively worded items and strongly disagrees with all negatively worded items will have the highest possible scale score, 30. Conversely, a student who strongly agrees with all negatively worded items and strongly disagrees with all positively worded items will have the lowest possible scale score, 6. A student who is neutral to all items will have a score of 18.

Administration of Survey Form

The attitude survey was administered to all 1268 UMTYMP applicants in September, 1988. It was administered again in May, 1989 to students who completed the first year of the program.[1] The results presented in this paper will be limited to the data for the 91 students who responded to the survey on both occasions.

Aptitude and Achievement Variables

Aptitude Measure

Students are selected for the UMTYMP on the basis of their scores on a special mathematics aptitude measure. The aptitude test is a modification of the School and College Ability Test, Form X (ETS, 1979). The measure consists of 50 multiple-choice questions designed to assess mathematical reasoning and computational ability. The aptitude test is administered each September to over 1000 applicants and roughly 120 are selected. In the fall of 1988, applicants who had a raw score of 42 or higher were admitted to the UMTYMP.

Achievement Measures

Students in the UMTYMP program are assigned grades on a trimester basis during the first year. Grades ranging from A+ to C- were assigned each term. For purposes of data analysis grades were coded as follows: A+ = 9, A = 8, ..., C- = 1.

Results

Reliability of Attitude Scales

Two different types of reliability data were obtained for each of the attitude scales. Internal consistency coefficients (α) were calculated for each scale on each administration (Fall and Spring) for males and females separately. The resulting α-

[1] Verb tenses in certain items were changed in the survey form for the May administration to reflect the fact that students had spent nine months in the program at the time they responded on the retest.

values are presented in Table 1. Generally speaking, the internal consistencies are quite respectable in view of the fact that there are only six items in each scale. There are two scales, Readiness and Support, which have unacceptably low internal consistencies ($\alpha < .70$). Analysis of the inter-item correlations on these two scales revealed generally low relationships among items with no individual item dramatically altering the α-value.

Insert Table 1 about here

The correlations of fall and spring attitude scores for males and females are also presented in Table 1. In general, the females exhibit more consistency over time with five test-retest correlations above the highest coefficient for males. The Interest scale shows very low consistency for both groups. There are interesting variations among scales with regard to the different types of reliability. For example, Interest exhibits reasonably high internal consistency but low stability, Support exhibits low internal consistency but high (relative to other scales) stability. The Stereotypes scale has high internal consistency for both sexes but reveals much higher stability for females than for males.

Differences Between Sexes in Attitudes

Table 2 presents the seven scale means and standard deviations for males and females separately for both the fall and spring administrations of the survey. The mean gender differences shown for fall tend to favor males on five of the seven scales. However, t-tests reveal that the differences are significant ($p < .05$) on only two of the seven scales. Males are more confident than females but females indicate a greater readiness for independent intensive study. The mean differences for spring favor males on six of the seven scales. However, none of the mean differences is statistically significant. Figure 1 graphically portrays the mean scores on both administrations of the survey.

Insert Table 2 and Figure 1 about here

Fall-Spring Changes in Attitudes

For both males and females there is a uniform tendency for attitudes to become more negative from fall to spring on all seven scales (see Table 2 and Figure 1). The difference is significant ($p < .05$) for both sexes on four scales: Interest, Motivation, Confidence and Priorities. In addition, for females there is a significant negative change on the Readiness scale.

Differences Between Sexes on Aptitude and Achievement

Means and standard deviations for the aptitude, attitude and grade variables are given for both males and females in Table 3. The average aptitude score for males is significantly higher ($p < .05$) than for females but the three differences in grade averages are not significant. However, it is interesting to note that the grade averages decline over the three terms for both males and females with females showing a somewhat larger decline.

Insert Table 3 about here

Relationships Among Variables

Correlations among the aptitude, attitude and grade variables are presented in Table 4. There are several noteworthy features in this table.

1. The correlations of aptitude with grades decrease from the first to the third trimester. However, the relationship between aptitude and grades is always higher for girls, especially for the first trimester. (Of course, there is an attenuation in correlations involving aptitude due to its use as a selection variable.)

2. The correlations among the three grades decrease over time but the relationships are always higher for boys, especially those involving the first trimester grades.

3. The attitude scales which exhibit the strongest relationships with grades for girls are Interest and Priorities. For boys the scale with the strongest association with grades is Stereotypes. However, the relationship is not in the predicted direction in this case.

Insert Table 4 about here

Multiple regression analyses were performed separately by gender using each of the three grade variables as the dependent variable. Since aptitude scores are used as the selection variable, it was decided to obtain a "forward solution" using aptitude as the initial predictor. This will reveal what, if any, attitude scale(s) combine with aptitude to enhance the prediction of grades. Results are shown in Table 5.

For males, no attitudinal variable was added to aptitude as a useful predictor of grades in the first and third trimesters. In addition, aptitude itself is not a useful predictor of grades in the third term. However, in the second trimester the Stereotypes and Confidence scales combine with aptitude to improve the prediction of grades.

For females, aptitude alone is the only useful predictor for the first trimester. But in the second and third terms the Interest scale combines with aptitude to improve the prediction of grades. In addition, grades for girls are generally more predictable than are those for boys.

Insert Table 5 about here

Implications

The most striking finding in this study is the uniform (and often statistically significant) negative change in attitudes exhibited by both males and females. Whether this reflects a "burnout" associated with the academic year cycle or a more

fundamental and permanent change will require further study. Clearly, it is an outcome that educators should be cognizant of in planning programs for talented youth.

There appears to be reliable sex differences in the pattern of relationships between classroom grades, aptitude scores, and self-reported attitudes. Generally speaking, for girls the relationships are stronger and the grades are somewhat more predictable than for boys. If these results can be replicated with larger samples it may be possible to develop an Interest scale which will help identify girls that are "good risks" in the UMTYMP and consequently reduce the current (higher) attrition rate for females.

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Table 1
Reliabilities of Attitude Scales

	Males (n = 62)			Females (n = 29)		
	Alpha		Test-Retest	Alpha		Test-Retest
	Fall	Spring		Fall	Spring	
Interest	.77	.81	.23	.87	.74	.12
Motivation	.72	.87	.31	.83	.87	.42
Confidence	.91	.87	.39	.90	.89	.39
Readiness	.49	.59	.39	.34	.59	.51
Support	.62	.46	.42	.54	.68	.52
Priorities	.83	.91	.38	.91	.88	.46
Stereotypes	.78	.82	.29	.91	.81	.60

Table 2

UMTYMP Attitudinal Survey Results

	Males (n = 62)				Females (n = 29)			
	Fall		Spring		Fall		Spring	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Interest	26.06	3.53	24.04	4.44	25.59	4.01	23.10	3.90
Motivation	26.13	2.96	23.23	4.24	25.34	3.38	22.38	3.96
Confidence	25.68	3.92	22.68	4.98	23.79	4.04	21.24	5.13
Readiness	22.82	2.81	22.54	3.63	24.14	2.85	22.17	3.84
Support	23.12	3.04	22.95	3.05	22.62	2.99	22.07	3.63
Priorities	22.71	4.37	20.37	5.17	22.07	4.73	18.62	4.54
Stereotypes	19.60	3.82	19.37	4.73	21.39	5.06	19.71	4.50

Table 3

Aptitude and Achievement Results

	Males (n = 62)		Females (n = 29)	
Variable	Mean	SD	Mean	SD
Math Aptitude	45.03	1.86	44.19	1.87
Grade 1	6.62	1.56	6.77	1.36
Grade 2	6.35	1.55	6.13	1.63
Grade 3	6.06	1.84	6.06	1.57

Table 4

Correlations Among SCAT, Attitude Scores,

and Grades by Gender[a]

	SCAT	INT	MOT	CON	READI	SUPP	PRIOR	STEREO	TG1[b]	TG2[b]	TG3[b]
SCAT	—	-.086	.053	-.131	-.069	-.211	.245	.046	.503	.200	.177
INT	.081	—	.480	.186	.293	.011	.712	.172	.249	.371	.380
MOT	-.108	.390	—	.521	.537	.248	.341	.485	-.123	.068	.106
CON	.038	.389	.667	—	.396	.323	.242	.496	.085	.185	.123
READI	-.190	.204	.457	.376	—	.191	.383	.140	-.083	.126	-.091
SUPP	-.029	.230	.346	.274	.224	—	.000	.001	-.045	.013	.093
PRIOR	.085	.652	.410	.386	.254	.090	—	.158	-.026	.250	.291
STEREO	.054	.395	.374	.380	.210	.478	.410	—	-.093	.038	.156
TG1	.260	-.081	.012	.073	-.010	-.174	-.011	-.210	—	.503	.200
TG2	.164	-.050	.150	.151	.026	-.201	.036	-.271	.778	—	.722
TG3	.127	-.023	.068	.119	-.030	-.076	.007	-.198	.593	.729	—

[a] Correlations for females appear above the diagonal. Correlations for males appear below the diagonal.

[b] TG1 = First Trimester Grade, TG2 = Second Trimester Grade, TG3 = Third Trimester Grade

Table 5

Summary of Stepwise Regression Analyses
for Females (N=31) and Males (N=63)

	Dependent Variable											
	Tri 1				Tri 2				Tri 3			
	F		M		F		M		F		M	
	IV	R^2	IV	R^2	IV	R^2	IV	R^2	IV	R^2	IV	R^2
Step 1	SCAT	.253	SCAT	.068	SCAT	.040	SCAT	.027	SCAT	.031	SCAT	.016
Step 2	—	—	—	—	INT	.167	STEREO	.096	INT	.166	—	—
Step 3					—	—	CON	.173	—	—		

APPENDIX A

UMTYMP SURVEY

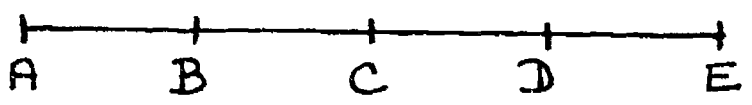
PLEASE DO NOT OPEN UNTIL TOLD TO DO SO.

UMTYMP SURVEY

Please do not turn the page until told to do so.

Directions:

1) Read each statement.
2) Think about how closely each statement describes you.
3) After you decide how closely each statement describes you, write this on your answer sheet. To do this, fill-in the circle on your answer sheet that matches how much your agree or disagree with each of the statements. Use this scale to help you:



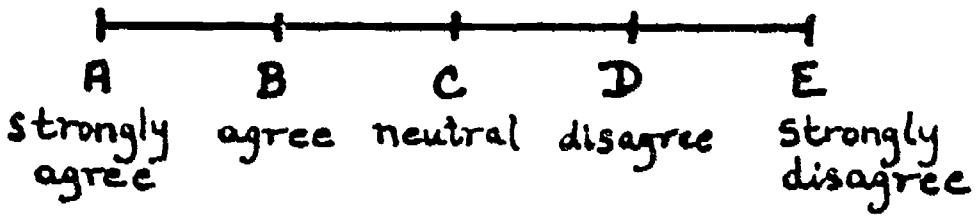
FILL IN THIS LETTER	IF YOU
A	strongly agree with the statement
B	agree (but not strongly) with the statement
C	feel neutral (neither agree nor disagree)
D	disagree (but not strongly) with the statement
E	strongly disagree with the statement

EXAMPLE:

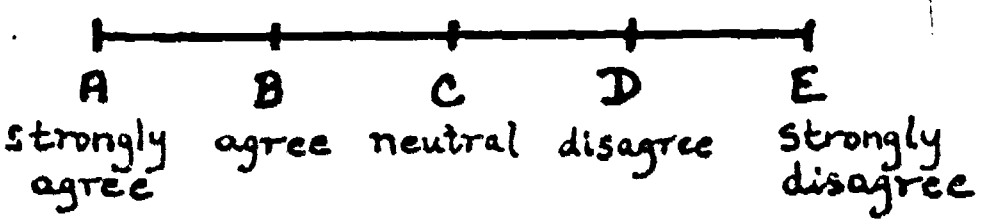
17) I don't mind spending a long time on my homework.

Remember:

* There are no right or wrong answers. Don't be afraid to put down what you really think.
* Don't spend a lot of time on any one item. Move quickly!
* Try to complete all 42 items.
* When you're done, please put your pencil down and wait quietly.



1) I wouldn't mind giving up some of the time I spend with my friends so I could be in an advanced math class.
2) My math teacher at my regular school really doesn't care whether or not I get into an advanced math class.
3) I don't give up easily when working on a difficult math problem.
4) I think I could do a good job in an advanced math class.
5) When I'm stuck on a problem, I'm afraid to ask my math teacher for help.
6) I really don't want to take an advanced math class.
7) Participating in a number of extra-curricular activities is more important to me than participating in an advanced math class.
8) It doesn't bother me to work on my math homework by myself.
9) I' m concerned that the kids at my regular school would think I was a nerd if they knew I was in an advanced math class.
10) I'm not being pushed to participate in the University of Minnesota advanced math class.
11) If I'm having a hard time solving a math problem, I usually won't try to finish it.
12) I am afraid I wouldn't do a good job in an advanced math class.
13) Kids at my regular school would think it's cool for me to be in an advanced math class.
14) I don't want to be in an advanced math class.
15) I don't mind giving up some of my other activities in order to participate in an accelerated math class.
16) My parent(s) will be happy for me if I take an advanced math class.
17) I am a hard worker when it comes to solving difficult math problems.



18) I wouldn't like to work on my math homework by myself.

19) My math teacher at my regular school will be happy for me if I take an advanced math class.

20) The kids at my regular school would think I was kind of weird if I took an advanced math class.

21) I would be willing to cut down on the number of activities I participate in so I could be in an advanced math class.

22) I think advanced math will be too hard for me.

23) I think the kids at my regular school would admire me if I was in an advanced math class.

24) I like to try to figure out difficult math problems for myself.

25) When I have a lot of homework to do, I work on it a little bit each day.

26) I really want to get into a special accelerated math class.

27) My parent(s) really don't care whether or not I get into an advanced math class.

28) If I'm having a hard time with a math problem, I'm not afraid to ask my teacher for help.

29) I have a lot of self-confidence about taking advanced math.

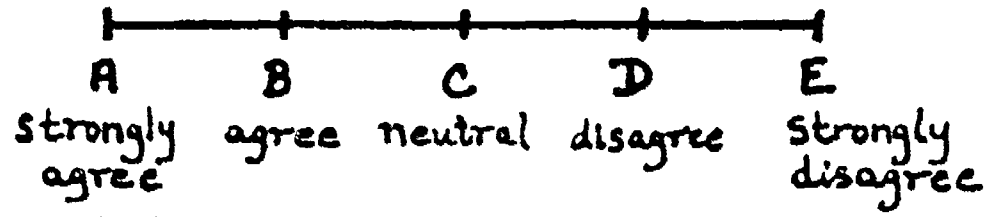
30) My friends really don't care whether or not I get into an advanced math class.

31) I feel like I'm being pushed to participate in the University of Minnesota accelerated math class.

32) I don't want to give up any of my free time to be in an advanced math class.

33) Other kids think students in advanced math classes are cool.

34) I'm not sure I will do well in an advanced math class.



35) I want to be in an advanced math class.

36) When a math problem gets too tough for me, I stop trying.

37) My friends will be happy for me if I take an advanced math class.

38) It would bother me if I had to give up some of the time I spend with my friends in order to be in an advanced math class.

39) I think I could handle advanced mathematics.

40) Even when I have a lot of homework, I usually do it at the last minute.

41) I'd rather wait for the teacher to explain the answer to a difficult math problem than try to figure it out for myself.

42) Other kids think students in advanced math classes are nerds.