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ABSTRACT

This study investigated the relationship between attitudes toward mathematics, career interests, and parent variables measured at grade eight and attitudes toward mathematics and career interests as measured at grade twelve. The longitudinal nature of the study will help to determine changes in mathematics attitudes and career interests from the junior to the senior high school level. The subjects were 458 high school seniors from midwestern senior high schools who participated in the first phase of the study as eighth graders. The instruments administered to the students included the Fennema-Sherman Mathematics Attitudes Scales and the Unisex American College Testing Interest Inventory (UNIACT). Canonical correlation analysis was used to determine the relationship between students' attitudes toward mathematics and career interests at the twelfth grade level and their parents' attitudes toward mathematics four years earlier. (DWH)

A Longitudinal Study of Career Interests and Mathematics Attitudes for Students at the Eighth and Twelfth Grade Levels

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Abstract

The purpose of this study was to conduct the second phase of an investigation of mathematics attitudes and career interests. The subjects were students from nine midwestern senior high schools who participated in the first phase of the study as eighth graders. The instruments administered to the students included the Fennema-Sherman Mathematics Attitudes Scales and the Unisex ACT Interest Inventory. Canonical correlation analysis was used to determine the relationship between students' attitudes toward mathematics and career interests at the twelfth grade level and their parents' attitudes toward mathematics four years earlier.

A Longitudinal Study of Career Interests
and Mathematics Attitudes for Students
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Investigation of both affective and cognitive variables related to the study of mathematics and to mathematics achievement is at the forefront as an area of research in mathematics education. Furthermore, the problem of females, as well as males, dropping out of the mathematics study sequence is of concern to both mathematicians and educators because of the increasing use of technology in almost all areas of employment.

Armstrong (1981) identified three variables, perceived need for mathematics for future careers and educational policies, positive attitudes toward mathematics, and the influence of significant others, including parents, teachers, and counselors, as having the greatest effect on continuation in the mathematics study sequence by high school women. Armstrong's conclusions were based on data collected through the National Assessment of Achievement and Participation of Women in Mathematics which focused on women age 13 and 17.

A relationship between parent attitudes and student attitudes toward mathematics has been reported by Parsons, Adler, and Kaczala (1982) and Wilhelm and Brooks (1980). Hill (1967) found that the attitudes of parents were related to the students' mathematical expectations and attitudes for junior high males. Parsons, Meece, Adler, and Kaczala (1982) found that parent attitudes differed with the sex of the child and appeared to influence mathematics achievement and student attitudes.

At the junior high level, Fox (1976) found that boys and girls who exhibited high academic potential differed in career interests and aspirations. At the high school level, Armstrong and Price (1982) found that career aspirations influenced mathematics participation and achievement. Astin (1968) predicted career interests at twelfth grade from ninth grade mathematics ability and Steel and Wise's (1979) findings supported the critical position of career interests at the high school level.

The influence of positive attitudes towards mathematics on mathematics achievement is supported by several researchers (Burton, 1979; Fennema & Sherman, 1978; Pedersen, Elmore, & Bleyer, 1985; Steel & Wise, 1979). In a limited longitudinal study, Sherman (1980) concluded that a student's view at grade eight of mathematics not being a male domain is a sign.ficant

predictor of problem-solving performance at grade eleven. She also concluded that stereotyping mathematics as a male domain in grade eight negatively affects female learning.

Since the junior high school years have been identified as pivotal relative to performance in mathematics, longitudinal studies such as those reported by Sherman (1981, 1982, 1983) are critical in identifying factors in evidence at the junior high school level which affect mathematics attitudes and career interests at the high school level and beyond. Additionally, investigating changes in attitudes and interests from the junior high to the high school level can provide valuable insights for both researchers and practitioners.

The objective of the present research was to investigate the relationship between attitudes toward mathematics, career interests, and parent variables measured at grade eight and attitudes toward mathematics and career interests as measured at grade twelve. The longitudinal nature of this study will help determine changes in mathematics attitudes and career interests from the junior high to the high school level.

Method

Subjects

Students who participated in a 1978 study (Pedersen, et al., 1985) as eighth graders during the 1978-1979 school year and who were in the twelfth grade during the 1982-1983 school year served as the subjects for the present study. Nine high schools and 458 students were involved in the longitudinal study.

Instruments

Data were collected from the students on attitudes toward mathematics and career interests at both the eighth and twelfth grade levels. Attitudes toward mathematics were measured by the Fennema-Sherman Mathematics Attitudes Scales (Fennema & Sherman, 1976). The nine scales are: Confidence in Learning Mathematics Scale, Teacher Scale, Usefulness of Mathematics Scale, Mother Scale, Attitude Toward Success in Mathematics Scale, Effectance Motivation Scale, Mathematics Anxiety Scale, Father Scale, and Mathematics as a Male Domain Scale. High scale scores indicate positive attitudes toward mathematics and low scale scores indicate less favorable attitudes toward mathematics. For the Mathematics as a Male Domain Scale, the higher the scale score, the less the student tends to stereotype mathematics as a male domain. For each item on the Fennema-Sherman Mathematics Attitudes Scales, students responded on a five-point scale (Strongly Agree, Agree, Neither Agree nor Disagree, Disagree, Strongly Disagree).

Career interests were measured by the Unisex ACT Interest Inventory (UNIACT) (The American College Testing Program, 1977). UNIACT is a sex-balanced interest inventory consisting of 90 items. It assesses the student's interest in each of six career areas: Natural, Social, and Medical Science; Creative and Applied Arts; Social, Health, and Personal Services; Business Sales and Management; Business Operations; Technology and Trade. The UNIACT also assesses two underlying dimensions of work-related activity preferences: a Data-Ideas dimension and a People-Things dimension. A higher score on the Data-Ideas dimension indicates more interest in data whereas a lower score indicates more interest in ideas. A higher score on the People-Things dimension indicates more interest in people whereas a lower score indicates more interest in things. For each item on the UNIACT, students responded on a three-point scale (dislike, indifferent, like).

The Fennema-Sherman Mathematics Attitude Scales and UNIACT were administered to the students as eighth graders in the 1978 study and to the same students as high school seniors in 1982-1983.

Additionally, information was obtained from the parents of the eighth grade students who participated in this study. This information consisted of each parents' responses to the Mathematics as a Male Domain Scale of the Fennema-Sherman Mathematics Attitudes Scales and to an adapted version of either the Mother Scale or the Father Scale. The adaptation of the Mother/Father Scales consisted of rewriting each statement to reflect the mother's/father's attitude toward her/his child as a learner of mathematics. For example, an item on the Mother Scale such as "My mother thinks I'm the kind of person who could do well in mathematics" was rewritten for the adapted parent version as "I think my child is the kind of person who could do well in mathematics."

Data Analysis Procedures

For all the variables investigated in this study, means, standard deviations, and correlations were calculated. Canonical correlation analysis was used to study the relationship between twelfth grade students' attitudes toward mathematics and their career interests, between twelfth grade students' attitudes toward mathematics and their parents' attitudes toward mathematics four years earlier, and between twelfth grade students' career interests and their parents' attitudes toward mathematics four years earlier. Canonical correlations were used

because of their appropriateness in settings in which the researchers are examining the relationship between two sets of variables. For each two sets of variables, canonical correlation analysis solves for two sets of weighting coefficients, which when applied to each set of variables, form composite variables that maximally correlate. In each canonical correlation analysis, multiple orthogonal sets of weighting coefficients were obtained. Each set is indicative of an independent pattern of relationships between the variable sets (Cooley & Lohnes, 1971).

Results and Discussion

Table 1 contains the means and standard deviations of all the variables in the study (both at the eighth grade and the twelfth grade levels).

Insert Table 1 about here

Table 2 contains the intercorrelations among the eighth and twelfth grade mathematics attitude variables used in the study.

Insert Table 2 about here

Table 3 contains the intercorrelations among the eighth and twelfth grade career interest variables used in the study.

Insert Table 3 about here

The results of the canonical correlation analysis that related twelfth grade students' attitudes toward mathematics to their career interests are shown in Table 4. Two canonical correlations were significant. The figures shown in Table 4 are the correlations, or loadings, of the original variables with the

Insert Table 4 about here

two canonical variates. For the first canonical variate, a positive attitude toward mathematics on all Fennema-Sherman Mathematics Attitude Scales was related to an interest in Natural, Social, and Medical Science; Social, Health, and Personal Services; Business Sales and Management; and, Business Operations. The second canonical variate indicated a relationship between a positive attitude toward mathematics on four scales of the Fennema-Sherman Mathematics Attitudes Scales (Confidence in Learning Mathematics, Usefulness of Mathematics, Effectance Motivation in Mathematics, and Mathematics Anxiety

Scales) with a positive interest in People-Things and Business Operations and a negative interest in Creative and Applied Arts and Social, Health, and Personal Services as measured by the UNIACT. The canonical redundancy analysis indicated that the canonical variates for students' attitudes toward mathematics explained 59 percent of their own variance and 16 percent of the variance in the students' career interests. The canonical variates for the students' career interests accounted for 40 percent of their own variance and 9 percent of the variance in the students' attitudes toward mathematics.

The results of the canonical correlation analysis that related twelfth grade students' attitudes toward mathematics with parents' attitudes toward mathematics four years earlier are shown in Table 5. Two canonical correlations were significant.

Insert Table 5 about here

The figures in Table 5 are the correlations of the original variables with the two canonical variates. For the first canonical variate, the students' positive attitude toward mathematics on all Fennema-Sherman scales except Attitude Toward Success in Mathematics and Mathematics as a Male Domain was related to a positive attitude of both the mother and father

toward their child as a learner of mathematics as measured by the Mother or Father Scale. The second canonical variate indicated a relationship between three scales of the Fennema-Sherman Mathematics Attitudes Scales (Attitude Toward Success in Mathematics, Mathematics as a Male Domain, and Father Scale) and measures on two variables, the mother not considering mathematics to be a male domain and a positive attitude of the father toward the child as a learner of mathematics. The canonical redundancy analysis indicated that the canonical variates for students' attitudes toward mathematics explained 53 percent of their own variance and 7 percent of the variance in the parents' attitudes toward mathematics. The canonical variates for the parents' attitudes toward mathematics accounted for 51 percent of their own variance and 5 percent of the variance in the students' attitudes toward mathematics.

The results of the canonical correlation analysis that related the twelfth grade students' career interests with the parents' attitudes toward mathematics four years earlier are shown in Table 6. One canonical correlation was significant.

Insert Table 6 about here

The loadings shown in Table 6 indicate that there was a significant relationship between interest expressed by students in Natural, Social, and Medical Science and in Business Operations and a positive attitude of both the mother and father toward their child as a learner of mathematics. The canonical redundancy analysis indicated that the canonical variate for students' career interests explained 13 percent of their own variance and 1 percent of the variance in the parents' attitudes toward mathematics. The canonical variate for the parents' attitudes toward mathematics accounted for 45 percent of their own variance and 5 percent of the variance in the students' career interests.

Conclusions

The influence of parent attitudes toward mathematics was demonstrated by the results of the canonical correlation analysis. A significant canonical correlation was found between the mothers' and fathers' perception of the child as a learner of mathematics and the child's positive attitude toward mathematics. The relationship of parental attitudes to the attitudes toward mathematics of their children supports the results of studies by Aiken (1972), Burbank (1970), Meece et al. (1982), Pedersen, Elmore, and Bleyer (in press), Stamp (1979) and Steel and Wise (1979). The canonical correlations also indicate a significant relationship between a positive attitude of both the mother and father toward their child as a learner of mathematics and interest expressed by students in Natural, Social, and Medical Science and in Business Operations.

The relationship between career interests and student attitudes toward mathematics as exhibited by the canonical correlations identify interest in the career areas of Natural, Social, and Medical Science; Social, Health, and Personal Services; Business Sales and Management; and, Business Operations as being significantly correlated with positive attitudes toward mathematics.

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Table 1

Means and Standard Deviations of all Eighth and Twelfth Grade Variables

Variables	Eighth Grade		Twelfth Grade	
	M	SD	M	SD
Student Mathematics Attitudes				
Confidence	3.75	0.74	3.35	0.95
Teacher	3.54	0.59	3.28	0.59
Usefulness	3.91	0.69	3.67	0.75
Mother	3.98	0.60	3.60	0.68
Attitude Toward Success	4.07	0.62	3.87	0.68
Effectance Motivation	3.33	0.73	2.99	0.83
Mathematics Anxiety	3.47	0.75	3.13	0.79
Father	3.97	0.67	3.64	0.75
Mathematics as a Male Domain	4.12	0.70	4.06	0.71

Variables	Eighth Grade M	Eighth Grade SD	Twelfth Grade M	Twelfth Grade SD
Parent Mathematics Attitudes				
Mathematics as a Male Domain-Mother	4.45	0.47	--	--
Mother Scale - Mother	4.19	0.53	--	--
Mathematics as a Male Domain-Father	4.25	0.58	--	--
Father Scale - Father	4.23	0.54	--	--

Variables	Eighth Grade M	Eighth Grade SD	Twelfth Grade M	Twelfth Grade SD
Student Career Interests				
Data-Ideas	13.00	4.71	14.27	5.71
People-Things	13.61	3.71	12.28	4.53
Natural, Social and Medical Sciences	1.90	0.56	1.84	0.62
Creative and Applied Arts	2.08	0.46	2.01	0.55
Social Health and Personal Services	2.04	0.40	2.17	0.45
Business Sales and Management	1.91	0.41	2.07	0.47
Business Operations	1.76	0.42	1.89	0.53
Technology and Trade	1.6	0.41	1.68	0.47

Note. All the descriptive statistics are based on a sample size of 355. That is the total number of subjects for whom complete data on all student and parent variables was available.

Table 2

Intercorrelations Among Eighth and Twelfth Grade Mathematics Attitude Variables

Eighth Grade Variables	Twelfth Grade Variables								
	1.	2.	3.	4.	5.	6.	7.	8.	9.
Student Variables									
1. Confidence	.50	.41	.38	.35	.30	.41	.44	.37	.15
2. Teacher	.31	.47	.29	.38	.41	.31	.25	.36	.24
3. Usefulness	.28	.35	.39	.33	.33	.29	.22	.35	.26
4. Mother	.27	.37	.31	.46	.32	.24	.21	.37	.17
5. Attitude Toward Success	.15	.21	.15	.29	.37	.16	.09	.25	.22
6. Effectance Motivation	.35	.36	.35	.31	.26	.44	.32	.28	.23
7. Mathematics Anxiety	.40	.32	.30	.25	.23	.35	.40	.27	.16
8. Father	.22	.34	.31	.46	.39	.24	.16	.56	.18
9. Mathematics as a Male Domain	.11	.19	.17	.24	.35	.15	.06	.23	.50

Eighth Grade Variables	Twelfth Grade Variables								
	1.	2.	3.	4.	5.	6.	7.	8.	9.
Parent Variables									
10. Mathematics as a Male Domain-Mother	-.02	-.01	-.02	.08	.06	.02	.01	.06	.11
11. Mother Scale - Mother	.22	.23	.21	.29	.11	.21	.23	.25	.08
12. Mathematics as a Male Domain-Father	-.01	.05	-.05	.09	.04	-.06	-.02	.05	.06
13. Father Scale - Father	.11	.18	.11	.24	.15	.11	.08	.27	.10

Note. All the correlations are based on a sample size of 355. That is the total number of subjects for whom complete data on all student and parent variables was available.

Table 3

Intercorrelations Among Eighth and Twelfth Grade Career Interest Variables

Eighth Grade Variables	Twelfth Grade Variables							
	1.	2.	3.	4.	5.	6.	7.	8.
1. Data-Ideas	.48	-.13	-.39	-.20	.00	.11	.18	-.15
2. People-Things	-.07	.46	.03	-.07	-.34	-.22	-.03	.28
3. Natural, Social and Medical Sciences	.25	.06	.45	.16	.10	.10	.09	.18
4. Creative and Applied Arts	-.19	-.14	.17	.43	.23	.17	.04	.08
5. Social, Health and Personal Services	.06	-.34	.08	.16	.42	.29	.12	-.04
6. Business Sales and Management	.23	-.18	-.03	.08	.23	.40	.25	.04
7. Business Operations	.25	.01	.01	.03	.07	.27	.37	.09
8. Technology and Trade	.00	.26	.10	.09	.03	.11	.13	.43

Note. All the correlations are based on a sample size of 355. That is the total number of subjects for whom complete data on all student and parent variables was available.

Table 4

Loadings from the Canonical Correlation Analysis of Student Mathematics Attitudes and Student Career Interests

Student Mathematics Attitudes Twelfth Grade			Student Career Interests Twelfth Grade		
	Loadings			Loadings	
Fennema-Sherman Math Attitude Scales	CV1[a]	CV2	UNIACT Scales	CV1	CV2
Confidence	.46	.50	Data-Ideas	-.18	.31
Teacher	.69	.22	People-Things	-.36	.72
Usefulness	.73	.60	Natural, Social &		
Mother	.73	.09	Medical Science	.74	-.01
Attitude Toward			Creative & Applied		
Success	.87	-.25	Arts	.38	-.49
Effectance			Social, Health, &		
Motivation	.66	.46	Personal Services	.50	-.54
Anxiety	.42	.58	Business Sales &		
Father	.69	.10	Management	.47	-.11
Male Domain	.56	-.38	Business Operations	.62	.44
			Technology & Trade	-.06	.31

Note. $R_{c_1} = .55$, $F(72, 2690.1) = 4.07$, $p < .0001$.

$R_{c_2} = .39$, $F(56, 2385.6) = 2.20$, $p < .0001$.

[a] CV means Canonical variate.

Table 5

Loadings from the Canonical Correlation Analysis of Student Mathematics Attitudes and Parent Mathematics Attitudes

Student Mathematics Attitudes Twelfth Grade			Parent Mathematics Attitudes Four Years Earlier		
	Loadings			Loadings	
Fennema-Sherman Math Attitude Scales	CV1[a]	CV2	Parent Variables	CV1	CV2
Confidence	.74	-.21	Male Domain -		
Teacher	.77	.04	Mother	.00	-.58
Usefulness	.72	-.14	Mother Scale -		
Mother	.81	.26	Mother	.81	.09
Attitude Toward			Male Domain -		
Success	.28	.48	Father	.10	.34
Effectance			Father Scale -		
Motivation	.62	.02	Father	.59	.74
Anxiety	.67	-.25			
Father	.82	.49			
Male Domain	.05	.43			

Note: R_{c_1} = .37, F (36,1313.3) = 2.82, $p < .0001$.

R_{c_2} = .26, F (24,1018.6) = 1.99, p = .0033.

CV means Canonical variate.

Table 6

Loadings from the Canonical Correlation Analysis of Student Career Interests and Parent Mathematics Attitudes

Student Career Interests Twelfth Grade		Parent Mathematics Attitudes Four Years Earlier	
UNIACT Scales	Loading	Parent Variables	Loading
Data-Ideas	-.09	Male Domain - Mother	.44
People-Things	-.12	Mother Scale - Mother	.90
Natural, Social & Medical Science	.65	Male Domain - Father	.36
Creative & Applied Arts	.37	Father Scale - Father	.80
Social, Health, & Personal Services	.14		
Business Sales & Management	.23		
Business Operations	.63		
Technology & Trade	.16		

Note. $R_c = .33$, $F(32,1296) = 2.10$, $p = .0004$.