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ABSTRACT

This study compared attitudinal data on students who had dropped college preparatory science (academic terminal) in high school (N=55) with those who continued to enroll (academic continuing) in college preparatory science courses (N=108). Eight attitudes that have been hypothesized to be related to learning cognitive performance and enrollment in science were assessed. These were: science usefulness; confidence in learning science; science as a male domain; effectance motivation in science; success in science; teacher support; parental support; and peer support. The relationships between these attitudes (dependent variables) and sex (male, female), three grade levels (tenth, eleventh, twelfth), and science program (academic terminal, academic continuing) were examined. Among the results reported were those indicating that: (1) although there were no widespread differences in attitudes between males and females, females anticipated more positive consequences as a result of successful achievement in science; (2) academic continuing students saw more usefulness in the study of science, had more confidence in studying science, and liked science more; (3) perceived peer support toward the study of science was low regardless of the grade. The overwhelming significant differences favoring academic continuing students, regardless of sex, indicate the importance of attitudes in possibly reducing the attrition rate in science. (Author/JN)

DIFFERENCES IN ATTITUDES BETWEEN ACADEMIC CONTINUING AND ACADEMIC TERMINAL SECONDARY SCIENCE STUDENTS

by

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ABSTRACT

The purpose of this study was to compare attitudinal data on students who had dropped college preparatory science (academic terminal) in high school with those who continued to enroll (academic continuing) in college preparatory science courses.

Eight attitudes that have been hypothesized to be related to learning, cognitive performance, and enrollment in science were assessed. These were Science Usefulness, Confidence in Learning Science, Science as a Male Domain, Effectance Motivation in Science, Success in Science, Teacher Support, Parental Support, and Peer Support.

The attitude scales were administered to 108 academic continuing students and 55 academic terminal students in a Central Pennsylvania high school. The independent variables were two levels of gender (male, female), three levels of grade (tenth, eleventh, twelfth), and two levels of science program (academic terminal, academic continuing). The dependent variables were the previously mentioned eight attitude scales.

The data were analyzed using Multivariate Analysis of Variance and Duncan's Multiple Comparison Test. Significant differences ($P < .05$) were found for the main effects of gender, grade, and science program. There were no significant differences for any two- or three-way interactions.

Discussion of the results, implications, and suggested furture research are included.

DIFFERENCES IN ATTITUDES BETWEEN ACADEMIC CONTINUING AND ACADEMIC TERMINAL SECONDARY SCIENCE STUDENTS

Objective

The purpose of this study was to compare attitudinal data on students who had dropped college preparatory science (academic terminal) in high school with those who continued to enroll (academic continuing) in college preparatory science courses.

Eight attitudes that have been hypothesized to be related to learning, cognitive performance, and enrollment in science were assessed. These attitudes were Science Usefulness, Confidence in Learning Science, Science as a Male Domain, Effectance Motivation in Science, Success in Science, Teacher Support, Parental Support, and Peer Support. Gender, secondary grade, and science program have accounted for differences in these attitudes (Levin and Fowler, 1982; Levin and Klindienst, 1982). In addition, these attitudes have been related to differences with respect to science/mathematics enrollment and achievement (Armstrong, 1980; Fennema and Sherman, 1977, 1978; Lantz, 1980; Levin and Fowler, 1982).

Background

Much emphasis has recently been placed on the poor or inadequate science preparation of high school students in the United States. A majority of high school graduates are scientifically and technologically illiterate (Connell, 1982). There has been a continual decrease in science achievement of 9-, 13-, and 17-year-old students nationally in the last three National

Assessments of Educational Progress (1970, 1973, 1977) (National Assessment of Educational Progress, 1978).

This situation is a result of two nationally occurring trends. There is a severe shortage of qualified mathematics and science teachers (Klein, 1982; National Science Foundation and Department of Education, 1980), and fewer students are electing to enroll in chemistry and physics classes (Helgeson, et al., 1977). The decline in science students' enrollment is probably related to many interrelated factors such as lack of qualified teachers, methods of instruction, difficulty of the subject, students' academic abilities, and students' attitudes toward science.

Fennema and Sherman (1977, 1978) have documented differences in attitudes between males and females and related these differences to mathematics achievement. Armstrong (1980) and Lantz (1980) have indicated differences in attitudes as having predictive value in the voluntary election of optional high school mathematics courses.

Levin and Fowler (1982) and Levin and Klindienst (1982) have found differences in attitudes toward science with respect to gender, secondary grade, and science program. However, in both studies, the independent variable of science program was confounded by being unable to control for academic ability of the students enrolled in the various science programs. To start to control academic ability, Levin and Fowler (1982) recommended that future research should consider comparisons between those students who were enrolled in academic (college preparatory) science programs and dropped out (academic terminal) and those that continued academic science study throughout high school (academic continuing).

Thus, this study compares the attitudes toward science of academic terminal and academic continuing high school science students. Since it is assumed that both types of students have the abilities to pursue college preparatory science, differences in attitudes may represent a possible cause as to why some students continue with college preparatory science throughout high school, while other academically able students decide to terminate their study of science.

Methods

Each of the eight attitude scales consisted of twelve items, six positive and six negative. There were five response alternatives. The alternatives were strongly agree, agree, undecided, disagree, and strongly disagree. Each response was given a score from 1-5 with the weight 5 corresponding to the response that was indicative of a positive attitude toward science instruction. A student's total score on each attitude scale was the cumulative total of each item score. The higher the score, the more positive the attitude.

The Science as a Male Domain Scale was interpreted somewhat differently. The less a student stereotyped science, the higher the score. This was done because it was assumed that the less a female stereotyped science as a male domain, the more apt she would be to study and learn science.

The eight scales were randomly assigned into one 96-item science attitude packet. Students were requested to record their sex, grade, and the science courses they had taken, or planned to take, in high school. With the science course information, the science coordinator of the district was able to identify those students who were pursuing an academic terminal or academic continuing science program. An academic terminal student was defined as

one who had taken, or planned to take, only one college preparatory science course in high school. An academic continuing student was defined as a student who had taken, or planned to take, two or more college preparatory science courses in high school.

Data Source

The attitude packet was administered to all students (N = 163) enrolled in a college preparatory science course in grades tenth through twelfth in a Central Pennsylvania high school during the Spring of 1982. The sample was partitioned into academic terminal students (N = 55) and academic continuing students (N = 108) (Table 1).

The attitude packet represented the eight dependent attitude variables previously mentioned. The independent variables included two levels of gender (male, female), three levels of grade (tenth, eleventh, twelfth), and two levels of science program (academic terminal, academic continuing).

Analysis and Results

The data were analyzed as an interaction model. Each individual's score on any dependent variable was seen to be represented by a linear combination of three main effects (gender, grade, science program), three two-way interaction effects (gender x grade, gender x science program, grade x science program), and one three-way interaction (gender x grade x science program).

The statistical Analysis System (SAS) was used to analyze the data (Statistical Analysis System Institute, 1979). Due to the unbalanced nature

of the sample cell sizes, the General Linear Model Procedure (GLM) of Multivariate Analysis of Variance (MANOVA) was used to test for significant main and interaction effects. Duncan's Multiple Comparison Test was used for mean separation procedures.

There were significant ($P < .05$) differences for the main effects of gender, grade, and science program (Table 2). The mean separation procedures on the individual attitude scales revealed three significant differences ($P < .05$) for the main effect of gender (Success in Science, Science as a Male Domain, Peer Support) (Table 3). Females anticipated more positive consequences as a result of successful achievement in science. Males stereotyped science as a male domain to a much greater extent than females, who had very little stereotypic attitudes toward science. Perceived peer support for the study of science was low for both sexes. However, males felt that they did receive more support from their peers chan did females.

Similar analysis showed seven significant ($P < .05$) differences for the main effect of science program (Usefulness of Science, Confidence in Learning Science, Success in Science, Effectance Motivation, Teacher Support, Parental Support, Peer Support) (Table 4). Academic continuing students saw more usefulness in the study of science, had more confidence in the study of science, anticipated more positive consequences as a result of success in science, liked science more, and perceived more support for the study of science from teachers, parents, and peers than did academic terminal science students.

There were two significant ($P < .05$) differences for the main effect of grade (Peer Support, Parental Support) (Table 5). Generally, twelfth grade students perceived less support toward the study of science from parents and peers than did tenth or eleventh grade students. Again perceived peer support toward the study of science was low regardless of the grade. However, twelfth grade students felt that they received less support from peers than did tenth or eleventh grade students. Students in tenth grade perceived more parental support toward the study of science than did students in eleventh and twelfth grades.

There were no significant differences for any two-way or three-way interaction effects (Table 2).

Discussion

The results of this study did not uncover widespread differences in attitudes between males and females. The significant difference favoring females on the Science as a Male Domain Scale was consistent with findings in science (Levin and Fowler, 1982) and mathematics (Fennema and Sherman, 1977, 1978). However, females did perceive significantly less support from their peers. This lends some support to Fox's (1979) hypothesis that, although females may not stereotype a subject, they perceive such attitudes from their peers, especially males, who in this study stereotyped science as a male domain to a greater extent than females.

Females had a significantly higher mean on the Success in Science Scale. This finding was consistent with those of Levin and Fowler (1982) and do not support Horner's (1972) fear of success hypothesis.

Although non-significant, females had a higher mean on the Teacher Scale, which does not support the differential treatment of teachers favoring males, as reported by Bean (1976); Good, et al. (1973); Levy (1972).

In all the scales except Science as a Male Domain, attitudes generally decreased from tenth to twelfth grades. This finding is consistent with Levin and Fowler (1982) and Levin and Klindienst (1982), who found that attitudes toward science were lowest in twelfth grade students. This finding is particularly noteworthy, since twelfth grade students are thinking about, planning, and making decisions concerning future educational and career goals.

The overwhelming significant differences favoring academic continuing students, regardless of gender, indicate the importance of attitudes in possibly reducing the attrition rate in science. Science teachers must consider the attitudes of their students. Curriculum and instructional strategies should be designed to reflect the importance of developing positive student attitudes. Thus, there are implications for both inservice and preservice teacher training.

Future research is needed. Particular emphasis should be given to studies that afford tighter control for academic abilities, predictive analysis that attempts to relate attitudes with voluntary course enrollment, descriminant

analysis that attempts to identify which attitudes have descriminating powers, the specification of the peer scale into support from peers of the same and opposite sex, correlational studies that relate teacher/student attitudes, and, finally, the design and evaluation of pre and inservice courses developed to aid teachers in improving students' attitudes toward science.

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Table 1

Cell and Marginal Sample Sizes

Grade	Academic Continuing		Academic Terminal		Totals
	Sex		Sex		
	Male	Female	Male	Female	
10	32	17	4	4	57
11	21	15	10	8	54
12	12	11	10	19	52
Sub Totals	65	43	24	31	
Totals	108		55		163

Table 2

Results of the 2x3x2 MANOVA

		SSCP									
Source		Useful	Conf.	Succ.	Male	Motiv.	Teacher	Peers	Parents	df	F*	P
Sex	Useful	186.99									
	Confidence	146.82	115.29							1	8.78 (8,144)	.00<.05
	Success	-254.65	-199.96	346.80								
	Male Domain	-986.28	-774.45	1343.19	5202.26							
	Motivation	239.74	188.25	-326.49	-1264.52	307.37	54.14	363.46				
	Teacher	-100.62	-79.01	137.03	530.73	-129.01	-140.28	238.01	155.86			
	Peers	260.69	204.70	-355.03	-1375.07	334.24	-91.86					
	Parents	170.71	134.05	-232.49	-900.45	218.87						
Grade	Useful	140.56										
	Confidence	115.26	233.74							2	1.72 (16,288)	.04<.05
	Success	-58.98	180.46	150.46								
	Male Domain	-123.87	-23.11	22.47	153.38							
	Motivation	64.14	193.19	160.31	22.71	171.24						
	Teacher	76.22	214.77	176.45	18.64	188.54	207.86	245.52				
	Peers	-34.92	210.22	186.95	-71.57	199.31	217.54	226.92	767.72			
	Parents	307.34	367.46	238.49	-205.79	256.82	292.91					
Program	Useful	2542.32										
	Confidence	1679.61	1109.66							1	3.37 (8,144)	.00<.05
	Success	1167.49	771.32	536.14								
	Male Domain	-369.27	243.96	169.58	-53.64							
	Motivation	1459.90	964.50	670.42	212.05	838.33						
	Teacher	1159.71	766.18	532.56	168.45	665.95	529.02					
	Peers	726.32	479.85	333.54	105.49	417.08	331.32	207.50				
	Parents	1503.09	993.04	690.25	218.32	863.14	685.66	429.42	888.68			

Table 2

Results of the 2x3x2 MANOVA

SSCP

Source		Useful	Conf.	Succ.	Male	Motiv.	Teacher	Peers	Parents	df	F*	P
Sex x Grade	Useful	149.31										
	Confidence	-74.57	159.64							2	1.07 (16,288)	.38>.05
	Success	140.36	40.63	232.11								
	Male Domain	210.34	-143.11	163.30	308.15							
	Motivation	139.87	-9.39	186.17	178.23	160.88						
	Teacher	142.33	-49.91	152.95	193.92	143.78	139.33					
	Peers	37.53	-19.69	34.41	53.16	34.68	35.60	9.44				
	Parents	52.72	-36.14	40.69	77.32	44.54	48.56	13.33	19.40			
Sex x Program	Useful	161.42										
	Confidence	346.73	744.77							1	1.16 (8,144)	.33>.05
	Success	81.24	174.49	40.88								
	Male Domain	34.49	74.09	17.36	7.37							
	Motivation	132.62	284.88	66.74	28.34	108.97						
	Teacher	95.58	205.31	48.10	20.42	78.53	56.59					
	Peers	127.83	274.58	64.33	27.32	105.03	75.69	101.23				
	Parents	139.16	298.93	70.04	29.74	114.34	82.41	110.21	119.98			
Grade x Program	Useful	52.67										
	Confidence	64.24	128.69							2	0.99 (16,288)	.47>.05
	Success	119.33	191.74	312.76								
	Male Domain	63.93	45.82	115.34	98.15							
	Motivation	160.34	180.07	349.07	204.54	492.54						
	Teacher	7.32	6.22	14.09	10.62	23.12	1.16					
	Peers	91.17	94.57	191.30	121.30	282.70	13.57	163.33				
	Parents	54.59	86.11	141.59	53.78	160.17	6.54	88.04	64.15			

Table 2

Results of the 2x3x2 MANOVA

SSCP

Source		Useful	Conf.	Succ.	Male	Motiv.	Teacher	Peers	Parents	df	F*	p
Sex x Grade x Program	Useful	607.89								2	1.24 (16,288)	.24>.05
	Confidence	756.37	949.05									
	Success	406.26	508.76	272.85								
	Male Domain	395.93	496.45	266.17	259.71							
	Motivation	149.13	206.81	108.42	107.35	93.63						
	Teacher	555.89	679.34	366.43	356.13	103.27	527.54					
	Peers	378.89	474.77	254.59	248.38	101.89	341.29	237.55				
	Parents	437.69	527.27	285.38	276.75	60.87	427.24	265.52	353.06			
Error	Useful	14626.39										
	Confidence	9329.19	14326.31									
	Success	6713.73	5842.14	10141.16								
	Male Domain	4545.1	4708.89	6113.87	15727.06							
	Motivation	9257.08	7882.34	4847.68	3499.79	12332.39						
	Teacher	6579.63	7408.99	4849.82	5158.98	5154.24	10097.09					
	Peers	5424.16	5127.94	3427.38	1700.63	5069.64	4217.28	7191.86				
	Parents	8754.41	7733.02	5923.42	3284.57	5357.28	5601.52	4882.91	10045.95			
Total/ Adjusted for the Mean	Useful	18467.55										
	Confidence	12363.65	17767.14									
	Success	2390.34	7509.58	12032.79								
	Male Domain	4508.92	4628.54	8211.28	21809.72							
	Motivation	11602.82	9890.55	6062.32	2988.49	14505.75						
	Teacher	8516.06	9151.87	6277.43	6457.89	6228.42	11612.75					
	Peers	7081.51	6846.84	4137.47	952.78	6544.57	5092.01	8519.90				
	Parents	11419.71	10103.74	7157.37	2832.24	7076.03	7052.98	6254.35	12414.79			

* Using Wilk's Criterion

Table 3

Duncan's Multiple Comparisons

Between Sexes on Attitude Subscales

	Male	Female
Usefulness	46.85	44.70
Confidence	46.00	44.31
Success	46.79	49.72
Male Domain	45.05	56.39
Motivation	40.39	37.64
Teacher	42.98	44.14
Peers	39.34	36.34
Parents	47.98	46.01

Means connected with the same line are not significantly different at .05 level.

Table 4

Duncan's Multiple Comparisons

Between Science Programs on Attitude Subscales

	Academic Continuing	Academic Terminal
Usefulness	48.79	40.15
Confidence	47.33	41.11
Success	49.35	45.69
Male Domain	49.85	50.87
Motivation	41.01	35.47
Teacher	44.87	40.82
Peers	39.10	35.76
Parents	49.25	42.84

Means connected with the same line are not significantly different at .05 level.

Table 5

Duncan's Multiple Comparisons

Between Grades on Attitude Subscales

	Tenth	Eleventh	Twelfth
Usefulness	47.32	45.19	45.02
Confidence	46.47	45.74	43.35
Success	48.46	48.74	47.09
Male Domain	48.16	51.15	51.44
Motivation	40.02	39.96	37.33
Teacher	44.16	44.24	42.02
Peers	38.63	39.28	35.90
Parents	50.05	46.39	44.56

Means connected with the same line are not significantly different at .05 level.