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What Happens? Relationship of Age and Gender with Science Attitudes from Elementary to Middle School

This study examines the attitudes of 1008 students from rural New Mexico in elementary and middle schools from ages 9 through 14. A large decrease in science attitudes between the ages of 11 and 12 years, corresponding with the move from elementary to middle school was observed.

Introduction

This research evolved from the examination of the results of the implementation of a school based science enrichment program involving students from ages 9 through 14. One of the instruments given to the students is designed to measure science attitudes. Over the course of the study it has become obvious that a significant drop in science attitudes is taking place between the ages of 11 and 12 for these students. This research examines the relationship of age and gender on science attitudes.

Why do Science Attitudes Matter?

The study of the relationship between science attitudes and achievement has intrigued many researchers. Meta analysis of 43 studies (Willson, 1983) and 66 studies (Steinkamp & Maehr, 1983) found significant correlational relationships between attitude and achievement in science. Individual studies examining the relationship between attitude and achievement in science have also been examined: for longitudinal relationships (Simpson & Oliver, 1990), for high school students (Reynolds & Walberg, 1992), for eighth graders by gender and ethnicity (Catsambis, 1995), for 10th graders (Young, Reynolds, & Walberg, 1996), by impacts of instructional strategies (Houtz, 1995), for differences across gender over time (Mattern & Schau, 2002), and in Cypress (Papanastasiou & Zembylas, 2002). All found correlational relationships between attitudes and achievement in science.

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Some of the research also narrows the focus by examining the influence of age and/or gender on both science attitudes and achievement. A meta study (Fleming & Malone, 1983) of research utilizing studies from kindergarteners through 12th grade spanning 1960 through 1983 concluded that as age increased the relationship with achievement increased and with attitude decreased. Gender differences indicated a weak superiority of male attitudes and achievement over females. A more recent meta analysis (Weinburgh, 1995) of 18 studies found males to have more positive attitudes than females. The correlation between attitude and achievement was positive for both genders but stronger for females. Catasabis found that female achievement was equal to male achievement but that females had less positive attitudes toward science (Catsambis, 1995). Conversely in China, Boone found that females had more positive attitudes than males (Boone, 1997). The impact of science enrichment programs on attitudes found more changes for females (Stake & Mares, 2001). Utilizing a structural equation model Mattern and Schau found that for males increases in positive attitudes toward science did not lead to greater achievement or more positive attitudes in the future. For females achievement was also not impacted by attitude. However, for females previous positive attitudes toward science did indicate more positive attitudes in the future (Mattern & Schau, 2002).

The impact of age and gender on science attitudes and achievement is plainly an area of interest for those in the field. Most of the research is correlational and does not hypothesize the direction of causality between attitude and achievement in science. It is apparent that positive attitudes and achievement are related.

Methodology

Data Source

The students are located in a rural area outside of Albuquerque, New Mexico. Six elementary schools and three middle schools in two districts are represented. A total of 1080 students (595 females and 485 males) ranging in age from 9 years old to 14 years old are included in the sample.

The data for the present analysis is from a school based science program collected over a three-year period from 2003 to 2005 at the beginning of each fall semester. School begins the middle of August and the data were collected from the end of August through the beginning of October each year. The overall study seeks to examine changes in various attitudes and knowledge for the program. Pretests and posttests are collected each year. The data used here represents only the pretest data, before the students are exposed to the program. Data were collected only once from each student, each age group represents a different group of students, not the same students over a five-year period.

Science Attitude Survey

The Science Attitude scale consists of 10 items designed to evaluate the participant's feelings and attitudes about science such as "Science is fun" and "I would like to learn more about science". These items were culled using item analysis after two years of administering a longer 25 item instrument. All questions are scored on a Likert scale from 1 to 6 ranging from Very False to Very True. The total score for the Science Attitude scale is the mean score for the 10 items. Thus the minimum possible score for the Science Attitude scale is 1 and the maximum is 6. All questions are renormed so that a higher value indicates a more desirable outcome. Cronbach's alpha for the science attitude instrument is $\alpha = .96$ using the overall sample. Reliability greater than $\alpha = .7$ is considered good (Litwin, 1995; Nunnaly, 1978).

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Results

The initial consideration of possible relationships between the variables developed when results from the first year of data indicated that age was a confounding variable for measuring science attitudes. At first this was thought to be an anomaly, perhaps based on the sample used for that year. However, after collecting pretest data for three years it became unambiguous that the decline with age was non- linear. The mean science attitude scores by age and gender are plotted in Figure 1 below. Statistics for science attitude by age and gender are reported in Table 1.

A two way factorial ANOVA with Gender and Age as fixed factors and Attitude toward Science as the dependent variable was conducted. This method was used rather than regression due to the non-linear relationship between the variables which

Figure 1: Science Attitude Score by Age and Gender

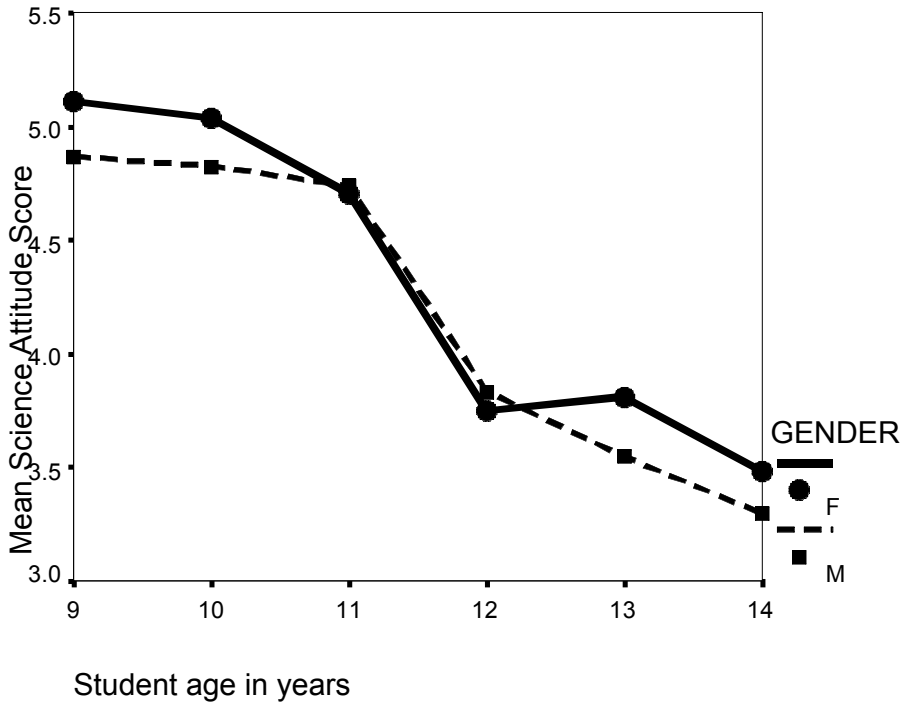

Table 1: Means, Standard Deviation and N for Science Attitude by Age and Gender

Student age in years	Gender	Mean Science Attitude Score	Std. Deviation	N
9	Female	5.11	1.07	61
	Male	4.87	1.13	59
	Total	*4.99*	*1.10*	*120*
10	Female	5.03	0.88	86
	Male	4.82	1.00	76
	Total	*4.93*	*0.94*	*162*
11	Female	4.70	1.11	148
	Male	4.74	1.12	120
	Total	*4.72*	*1.11*	*268*
12	Female	3.75	1.33	189
	Male	3.83	1.33	146
	Total	*3.78*	*1.33*	*335*
13	Female	3.81	1.26	81
	Male	3.55	1.38	69
	Total	*3.69*	*1.32*	*150*
14	Female	3.48	1.50	30
	Male	3.30	1.69	15
	Total	*3.42*	*1.55*	*45*
Total	Female	4.30	1.33	595
	Male	4.28	1.34	485
	Total	*4.29*	*1.34*	*1080*

was observed when plotting the data. Results are presented in Table 2.

No significant interaction between gender and age was found $F(5,1068)=.815$, $p=.539$. The relationship of gender was also not significant $F(1,1068)=1.92$, $p=.167$. The relationship of age on attitude toward science was significant $F(5,1068)=46.88$, $p<.001$, partial $\eta 2 =.18$, $\eta =.42$. This represents a large effect size (Cohen, 1988).

A trend analysis indicated that the data were fit by a linear model ($p<.001$, $\eta^2 =.15$) with a quadratic component ($p=.003$, $\eta^2 =.01$).

Post hoc analyses of the differences across grades were tested with the Games-Howell multiple comparison procedure due to unequal variances (Games & Howell, 1976). Post hoc tests reveal that the 9, 10 and 11 year olds are not significantly different from each other. The 12, 13 and 14 year olds are also not significantly different from each other. However, these two groups of younger and older students do differ significantly from each other. The two homogeneous subsets of science attitude are comprised of the 9, 10 and 11 year olds and the 12, 13 and 14 year olds.

Discussion

In these school districts the move from elementary school to middle school occurs between 11 and 12 years of age. Thus, for the vast majority of students (the exceptions being accelerated students or those held back) science attitudes at age 11 reflect those of the last year of elementary school and those at age 12 represent the first year of middle school. Unmistakably a precipitous drop in science attitudes takes place between elementary school and middle school. As the students have only been attending middle school for a maximum of six weeks before they take the instrument this result is a cause for great concern. The effect

Table 2: Two Way Analysis of Variance for Science Attitude Scores as a Function of Age and Gender

Variable and Source	df	Mean Square	F	Partial η^2
Science Attitude				
Age	5.000	68.794	46.883**	0.180
Gender	1.000	2.811	1.916	0.002
Age * Gender	5.000	1.195	0.815	0.004
Error	1068.000	1.467		

**p<.001

Table 3: Means for Homogeneous Subsets of Science Attitude

Age Group	Mean	N	Std. Deviation
9, 10 and 11 year old students	4.84	551	1.07
12, 13 and 14 year old students	3.73	532	1.35
Total	4.29	1083	1.33

size for this change is large, representing a major drop in attitudes toward science over the course of one year. This descent occurs for both males and females at an equal rate. The students do not recover their previously higher levels of science attitude in the later middle school years.

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Limitations of this study are evident. New Mexico has a different demographic structure than much of the rest of the United States. The area including the students studied includes a larger proportion of persons of Hispanic or Latino origin (43 %) than the general population of the US (14%). Native Americans also comprise a larger percentage (10%) than the general US population (1%) and African Americans a smaller percentage (2% vs 13%). The number of persons living below the federal poverty line in the area is 17%, compared to 13% in US overall ("U.S. Census Bureau Data," 2007). As cultural factors have been shown to impact science attitudes (Ato & Wilkinson, 1983; Fisher & Waldrip, 1999; Lee & Burkam, 1996; Osborne, Simon, & Collins, 2003; Reynolds & Walberg, 1992) the relationships found in this study may not be applicable to a more general population.

Maturation of the subjects may also have played a role in the student's changes in attitude. Changes in development may impact attitudes as well as exposure to science over time.

Further research on the relationship of the move from elementary school to middle school to changes in science attitudes is merited. It would be helpful to determine if maturation or cultural influences are factors in this change. Examination of students from other cultures as well as consideration of students who do not change schools from elementary to middle school would yield further information about this relationship. Clearly for this group of students a change in their attitudes is concurrent with the move to middle school. Whether this change is more generally applicable requires further investigation.

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