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Attitudes of Kentucky College Students Toward Science

GEORGE H. MILLER
Division of Natural Sciences, University of Louisville,
Louisville, Kentucky 40208

ABSTRACT

This study investigated some attitudes toward science of 909 upperclass students in 3 large state universities and 9 small liberal arts colleges in Kentucky in relation to selected academic and vocational characteristics. The attitudes related to support of science and the scientific enterprise, and orientation toward scientific thought and habits.

Comparisons were made of students classified as to their academic area, hours of college course work in science, type of institution attended, and sex. The possible effects on attitudes due to interactions involving those variables were also investigated. An additional series of analyses involved prospective elementary and secondary teachers and those students not choosing teaching as their vocation.

College students attending large state institutions evinced stronger support toward science than students at small liberal arts colleges, as did students with more than 18 semester hours of course work in science, and students who majored in natural science subjects. Male and female students showed no difference in their support toward science. Students pursuing nonteaching careers were more positive toward science than elementary or secondary education students.

INTRODUCTION

Never before have the sciences been so much a part of the nation's culture. We live in a scientific civilization, an environment greatly influenced by the applications of science, with the general public in many ways aware of its importance and its influence on our daily lives.

A general awareness of the importance of science does not necessarily mean its functioning as a cultural activity of man is understood or universally supported, nor can we assume the learning of factual scientific information is always accompanied by the acquisition of desirable attitudes and thought processes (Shrigley 1974). The intent of this study was to investigate some attitudes of college students in Kentucky in relation to selected academic and vocational characteristics, as they relate to support of science and the scientific enterprise, and orientation toward scientific thought and habits. The Schwirian *Science Support Scale* (Tri-S) provided a measure of the extent of support toward science and the Vitrogan *Generalized Attitude Toward Science* (VGAS) scale assessed the orientation of respondents toward scientific thought. Comparisons were made of college students classified as to their academic area, hours of college course

work in science, type of institution attended, and sex. In consideration of their potential contribution to improving the overall orientation toward and support of science through their future roles in the classroom, an additional series of analyses was made involving prospective elementary teachers, prospective secondary teachers, and students not choosing teaching as their vocation. The possible effects on attitudes due to interactions between variables were also investigated. This study was not intended to determine where or how the attitudes were acquired, but to allow comparisons between various groups, and to identify factors associated with the attitudes.

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RATIONALE OF THE STUDY

Science educators are in general agreement as to the objectives of science education, as indicated by *Science Education in American Schools*, the Forty-sixth Yearbook of the National Society for the Study of Education, and their Fifty-ninth Yearbook, *Rethinking Science Education*. In the latter, Hurd (1960) summarized the objectives of science instruction as (1) acquiring a background of ordered knowledge, (2) developing inquiry processes for problem solving, (3) understanding the dependence of society upon scientific achievement and the interplay of science and human affairs, (4) acquiring appreciation for the importance of science and its contribution as a human intellectual activity, (5) acquiring skills and abilities for processing information and expanding self learning, and (6) formation of attitudes conducive to the use of knowledge and methods of science.

A more recent statement of the objectives of science education by Lombard and Owen (1965) specified 5 major objectives similar to those of Hurd. However, they placed the ability to apply the methods, techniques, and rational processes of science at the top of their list. They also stated that the success of the entire scientific enterprise depends to a great extent on the general attitude of its surrounding culture. Brown (1954) and Blough (1960) have expressed similar views for the need for desirable attitudes toward science.

Science in a technological society is not unique in kind but rather in its high degree of development and wide scope. The combination of elements indispensable for modern science are not immutable, and any altering of conditions will affect the progress of science. Parsons (1951:338) noted the relationship between science and society when he stated, "Science is intimately integrated with the whole social structure and culture condition. They mutually support one another—only in certain types of society can science flourish, and conversely, without a continuous and healthy development and application of science such a society cannot function properly." According to Nagel (1959), Seaborg (1970), and Bronowski (1965), any success at improving the quality of life and achieving a fuller sense of human dignity will result from a coordinated interplay of all our sciences and our social and philosophical outlook. All those forces must be used in a healthy combination, built around a common trust and understanding.

The Scientific Literacy Research Center at the University of Wisconsin was founded to work on problems associated with knowledge in and of science needed by a population living under democratic principles. As a result of a review of the literature from 1946 to 1964 concerning scientific literacy, science for general education, science for the citizen, and science and society, Pella et al. (1966) derived a set of referents describing a scientifically literate person.

Nonspecific in nature, but nevertheless occurring in a pervasive role, a constructive attitude toward science was identified as characteristic of such a person.

The National Science Teachers Association (1968) sponsored report, *Steps Toward Scientific Literacy, A Report of College-Level Conferences on Science for Non-science Majors*, stressed attitudes, interests, values, and appreciations as vital objectives if we are to achieve a scientifically literate society. Eiss and Harbeck (1969) cautioned that simply an increased awareness of facts about science often results in a greater dislike for science; therefore, we must concern ourselves with the attitudes and values of students, and place increased emphasis on objectives in the affective domain. Until educational programs consider such objectives, they will be inadequately evaluated. An analysis of research on instructional procedures led Ramsey and Howe (1969:70) to a similar conclusion when they said, "a student's attitude toward science may well be more important then his understanding of science since his attitudes determine how he will use his knowledge."

Helping young people achieve a realistic, practical, and constructive approach to science in their lives is a task that falls mainly on science instruction in the schools (Hawn 1960, Kuhn 1973). In addition, it would appear that the most opportune conditions for either acquiring constructive thought processes and attitudes or improving existing ones would be during the formal school years. Worth (1965) and Wittlin (1963) reported that behavioral traits and personality patterns are established during the early years, and changes during later years are difficult to effect. As a vocational group, teachers are in a position to serve as models for individuals whose attitudes are often as yet ill defined. The nature of the teaching function places teachers in a situation where they are relatively free to sanction or disapprove attitudes students exhibit. This is consistent with a statement by Watson (1967) to the effect that the teacher establishes the tone or social climate within which pupil learning occurs. A common suspicion is that there is a major relationship between the characteristics of the "whole teacher" and the learning of the "whole child."

The degree of association between a teacher's attitudes and characteristics, and student outcomes in the classroom has not been resolved, but a body of literature is accumulating that indicates significant relations do occur (Bixler 1958, Rosenthal and Jacobson 1968, Hone and Carswell 1969, Washton 1971, and Rothman 1969). Therefore, it would seem appropriate, if the objectives of science education are to be accomplished, that the attitudes toward science of prospective and in-service teachers must be given special consideration.

Previous efforts to assess attitudes toward science of various segments of the population are few in number and of questionable value. One limitation has been the unavailability of suitable instruments for assessment. Another has been preoccupation, until recently, with cognitive outcomes in the schools while minimizing affective objectives.

Considerable confusion is evident in the literature concerning the distinction between the possession of scientific attitudes and positive attitudes toward science. The former refers to the possession of thought processes and skills employed in using the scientific method, while the latter should properly be reserved for the state of mind mediating one's response to a psychological object, placing it in the affective domain. Another point that needs attention is the relatively frequent equating of accuracy of perception of science and favorableness of attitude toward science. Again, the first appears to be in the cognitive domain and the latter in the affective.

An early effort to assess the opinions of college students, in relation to the nature of science and its purpose in society (Wilson 1954), showed that nearly a third of the students thought science responsible for much of the evil in the world, and approximately half were in favor of federal

control for the financing and direction of all scientific research.

Another effort to determine the college student's concepts and perceptions of science and the scientist was reported by Mitias (1970). The instrument used to gather information contained 2 incomplete statements about science and the scientist that the student was asked to complete with the first response that came to mind. Responses similar in meaning were grouped together and summarized. Mitias observed 14 categories for "science" and 10 for "the scientist," with no dominating stereotyped concept for either topic. By assigning positive, neutral, or negative character to the responses, it was found that the concept of science as "a necessary evil" ranked second in frequency, and the first positive concept of science ranked fifth. The majority of observed concepts represented a neutral view.

The image of the scientist, as perceived by college students, was reported by Beardslee and O'Dowd (1961), who used a 48-scale semantic differential instrument. Data suggested a readiness to respond to the word "scientist" in a complex manner. The image was very similar for freshmen and seniors, but there was evidence that students entering college had a more favorable view of the scientist than students who had already spent a semester in college. The strong features of the image of the scientist were his intelligence and driving concern to extend knowledge and discover truth. The weaknesses in his image related to his being out of touch with life and uninterested in people and art, and a nonconformist with only moderate control of his impulses.

Snow and Cohen (1968) explored the prestige hierarchy among senior college students toward the natural sciences, the social sciences, and the humanities, and whether it was constant or influenced by continued professional specialization. The initial testing indicated that hierarchical professional evaluation was present on the undergraduate level, with science students exhibiting the most favorable attitude toward their own major, ranking the social sciences next, and humanities last. Among the social sciences and humanities students, their own group was placed with the sciences and they relegated the other (social sciences or humanities) to the least favorable position. With continued professionalization of the students, some modification was observed. The sciences exhibited a more favorable attitude toward the humanities rather than the scoial sciences, and social science graduate students exhibited equally favorable attitudes toward all professions.

Sadava (1976) compared the attitudes toward science of nonscience majors to those of the general public, as measured previously in a national survey by the Opinion Research Corporation. The results indicated the students had more negative opinions than the general population.

Most research on attitudes of teachers toward science attempted to measure or obtain opinions concerning science as an academic subject, or toward the teaching of science. Dutton and Stephens (1963) constructed a Thurstone type instrument intended to measure attitudes toward teaching elementary science, and reported generally favorable attitudes toward teaching science among prospective elementary teachers.

Kane (1968) used the semantic differential technique to assess the attitudes of prospective elementary teachers toward mathematics, science, language arts, and social studies as academic areas and as future teaching areas. He also measured their attitudes toward "teaching children," and found a significantly higher score for "teaching children" than for teaching children any of the specific academic areas. Presumably, they conceived the role of "teaching children" apart from teaching specific subjects to them. He did not find any significant differences among the group attitudes toward the 4 academic areas.

Schwirian (1969) employed her own instrument to determine which of 8 personal and professional characteristics were

related to 191 elementary teachers' attitudes toward science. Younger teachers possessed more positive attitudes than older teachers, and graduates of state schools were more favorable to science than graduates of liberal arts colleges, as were teachers with 10 or more semester hours of science course work. She concluded that the most positive teacher would most likely be a person under 40 years of age who graduated from a state school and had taken 10 or more hours of course work in science. A follow-up study by Schwirian (1972) produced results consistent with her earlier study.

An improvement in attitudes toward science, as measured by the *Purdue Master Attitude Scale* (Siemankowski 1969), was the result of an experimental general education science course using a wide variety of audiovisual aids, programmed learning, and an autopaced teaching process. The emphasis on individualized learning, although not affecting content achievement or understanding of science, was considered useful in improving attitudes. Recent studies attempting to identify conditions that contribute to a more positive attitude of teachers toward science are those of Barufaldi et al. (1977), Johnson et al. (1974), Kennedy (1973), Shrigley (1977), and Simmons and Esler (1972).

RESEARCH PROCEDURES

In order to assess the attitudes toward science of college students in Kentucky, all degree granting colleges in the state were invited to participate and provide access to their students. Twelve schools agreed to do so: 3 large state institutions, Morehead State University, Murray State University, and the University of Louisville, and 9 small private liberal arts colleges, Asbury College, Bellarmine College, Brescia College, Cumberland College, Kentucky Wesleyan College, Pikeville College, Spalding College, Thomas More College, and Union College participated. Each school offered a teacher preparation program, and collectively represented 60 percent of the schools in the state with such a program. The state schools all had enrollments of over 7,000 students while the private schools ranged from 800 to 2,000 students. Each private school was either affiliated with a religious denomination at the time of the study or had been in its past, though none restricts admission on the basis of religion.

TABLE 1.—CHARACTERISTICS OF 441 STUDENTS AT LARGE STATE SCHOOLS AND 468 STUDENTS FROM SMALL PRIVATE SCHOOLS IN KENTUCKY

	Large state schools	Small private schools	Total
Men	191	220	411
Women	250	248	498
Humanities	114	88	202
Natural sciences	126	103	229
Social sciences	201	277	478
Elementary education	113	121	234
Secondary education	140	159	299
Nonteaching	188	188	376

A total of 909 students was involved in the study, 468 from private colleges and 441 from state institutions. Since all subjects were juniors or seniors, all had completed a similar educational objective since each school required participation in a general education program during the first 2 years of study.

To effect as representative a sample as possible, an effort was made to include both male and female students majoring in the academic areas of humanities, natural sciences, and social sciences from each school. Since each school offered a teacher preparation program, an effort was made to include candidates at both the elementary and secondary levels in the sample (Table 1). The selection process was randomized to the extent possible when working with intact groups.

Permission was obtained to use attitude assessment instruments developed by Schwirian (1968) and Vitrogan (1967). Administration and processing of the data occurred the spring semester of 1971. Responses to the instruments and a personal data page were key punched on IBM

TABLE 2.—SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS FOR STUDENTS AT SMALL PRIVATE SCHOOLS AND LARGE STATE SCHOOLS AS DERIVED BY THE TRI-S AND VGAS SCALES

Scale	Type of school	n	Mean	$\hat{\sigma}$	t
Tri-S	Small private	468	107.06	11.89	4.47[1]
	Large state	441	110.71	12.72	
VGAS	Small private	468	188.06	20.94	2.01[2]
	Large state	441	190.08	20.10	

[1] Significant at the 0.01 level.
[2] Significant at the 0.05 level.

cards for processing on an IBM 360/40 computer.

The independent or main effect variables examined as possible sources of variance in the group means were (1) type of institution (state or private liberal arts), (2) semester hours of science (0 to 8, 9 to 17, 18 or more), (3) sex, (4) academic area (humanities, social sciences, natural sciences), and (5) vocational choice (elementary education, secondary education, nonteaching). The categories for semester hours of course work in science were chosen with the intention of separating students taking the minimum possible work in science, according to academic requirements in the catalogs, and students choosing additional science courses, from the group following the more typical academic nonscience program.

Possible interaction effects on attitudes toward science were investigated with the variables (1) sex and type of institution, (2) sex and hours of course work in science, (3) sex and academic area, (4) academic area and type of institution, (5) vocational choice and hours of course work in science, (6) vocational choice and sex, and (7) type of institution and teaching level.

The statistical procedures used in determining the significance of the differences in group means for the main effect variables were the t statistic for comparisons involving 2 means, and a one-way analysis of variance where more than 2 means were examined. Where significance occurred involving 3 or more means, an additional procedure was necessary to determine which means were significantly different. The procedure employed in this study involved the computation of multiple t tests. Stratification according to the different levels of the main effects involved in the possible interactions resulted in 2×2 and 2×3 analysis of variance designs. Interactions involve specificity of effect, whereby the effect of one variable changes, depending upon the specific value of the second variable. Interaction effects are relevant to generalization statements about the main effect variables, and limitations upon generalizability appear in the statistical analysis as significant interactions.

TABLE 3.—SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS FOR MEN AND WOMEN STUDENTS AT KENTUCKY COLLEGES AS DERIVED BY THE TRI-S AND VGAS SCALES

Scale	Sex	n	Mean	$\hat{\sigma}$	t
Tri-S	Men	412	108.37	13.03	2.04[1]
	Women	497	109.16	11.97	
VGAS	Men	412	187.87	20.55	0.96
	Women	497	190.66	20.51	

[1] Significant at the 0.05 level.

TABLE 4.—ANALYSIS OF VARIANCE FOR NUMBER OF SEMESTER HOURS OF SCIENCE BY STUDENTS IN SELECTED KENTUCKY COLLEGES AS DERIVED BY THE TRI-S AND VGAS SCALES

Scale	Source of variation	Sum of squares	df	Mean square	F
Tri-S	Hours of science	5,709	2	2,854.50	19.11[1]
	Within	135,339	904	149.38	
VGAS	Hours of science	1,760	2	880.00	2.08
	Within	382,528	904	422.22	

[1] Significant at the 0.01 level.

The criterion variables employed in this study reflect attitudes toward science. As an aid in determining the degree of relationship between the 2 estimates, scores were correlated for each group in the study. The intent of the analysis was to gain additional insight into the characteristics of specific groups.

RESULTS OF ANALYSES AND DISCUSSION

Results of analyses involving the *t* test for "type of institution" (Table 2) indicate that the type of institution attended is related to attitudes toward science as measured in this study. Students attending large state schools scored significantly higher on the Tri-S and VGAS scales than students at small private colleges. The *t* value of 4.47 on the Tri-S was significant at the 0.01 level. Analyses for "sex group" (Table 3) revealed that women are oriented toward scientific thought and processes to a greater extent than men, and a lack of significant difference as to support of science, although the trend in scores did favor women over men.

The summary of the analysis of variance involving the main effect variable "semester hours of science" in relation to the Tri-S and VGAS scales is given in Table 4. With 2 degrees of freedom in the numerator and 904 in the denominator, an F value of 19.11 for the Tri-S was highly significant at the 0.01 level and was the highest of 20 such values calculated. A multiple comparison test applied to the differences between the means on the Tri-S for "semester hours of science" was used to determine which of the means were significantly different and produced the large F value in Table 4. The mean attitude score for students with 18 or more semester hours of science was significantly higher than for students with 0 to 8 or 9 to 17 hours of science. No significant difference was found in the attitude scores for students with 0 to 8 hours of science and those with 9 to 17 hours.

Therefore, students with 18 or more semester hours of science evinced greater support toward science as a cultural activity than students who followed a typical nonscience program or those who elected to take other subjects in lieu of the available general education science (Table 5).

The summary of the analysis of variance involving the main effect variable "academic area" in relation to the Tri-S and VGAS scales is shown in Table 6. The F value for the VGAS was only 0.66, while a highly significant 9.04 was obtained for

TABLE 5.—RESULTS OF THE MULTIPLE COMPARISON TEST APPLIED TO THE DIFFERENCES BETWEEN MEANS ON THE TRI-S SCALE FOR SEMESTER HOURS OF SCIENCE TAKEN BY STUDENTS AT SELECTED KENTUCKY COLLEGES

Categories compared	n	Means	*t*
0–8 hours of science	266	107.84	0.94
9–17 hours of science	404	106.94	
0–8 hours of science	266	107.84	4.55[1]
18 or more hours of science	239	112.93	
9–17 hours of science	404	106.94	6.01[1]
18 or more hours of science	239	112.93	

[1] Significant at the 0.01 level.

TABLE 6.—ANALYSIS OF VARIANCE FOR ACADEMIC AREA PREFERRED BY STUDENTS AT SELECTED KENTUCKY COLLEGES AS DERIVED BY THE TRI-S AND VGAS SCALES

Scale	Source of variation	Sum of squares	df	Mean square	F
Tri-S	Academic area	2,761	2	1,380.50	9.04[1]
	Within	138,287	904	152.63	
VGAS	Academic area	560	2	280.00	0.66
	Within	383,680	904	423.49	

[1] Significant at the 0.01 level.

the Tri-S. A multiple comparison test was applied to the differences between means on the Tri-S for the "academic area" variable to determine which categories of the variable were significantly different. Natural science majors scored considerably higher than humanities or social sciences majors (Table 7). In each instance, the difference was significant at the 0.01 level. No significant difference was found in the attitude scores for students who majored in humanities or social sciences.

The results of the analysis of variance involving "vocational choice" (Table 8) reveal the F value on the VGAS scale to be nonsignificant at 0.34, while a highly significant 14.64 was obtained for that variable on the Tri-S. A multiple comparison test applied to the differences between the means on the Tri-S scale for the "vocational choice" variable (Table 9) was used to determine which means were significantly different and contributed to the large F values in Table 8. The decision to work toward a teaching position appears to be related to the degree of support afforded science (Table 9). The mean attitude score on the Tri-S for students not working toward a teaching position was considerably higher than the means for either prospective elementary or secondary teachers. There was no difference between the attitudes of students preparing to be elementary or sceondary teachers.

The analysis also tested for first-order interactions involving specific 2-variable combinations of the main effects. No significant interactions occurred, strengthening the generalizability of the previous results and the external validity of the research findings. The variables related to attitudes toward science do no depend upon specific values of the other variables for their effects to be manifested.

Although the 2 attitude scales were related, since a correlation of responses from each group in the study resulted in r values significantly different from zero, the degree of correlation was not impressive, and it appears that they measure, for practical purposes, different dimensions of attitude toward science. Secondary education students exhibited the highest relationships between the 2 scales with an r value of 0.4026, indicating slightly over 16 percent of the variance in one scale may be attributed to variance in the other scale for that group. Although statistically significant, the relationship for students not working toward a teaching position implies a variance accountability of less than 6 percent between the scales, certainly not an impressive relationship (Table 10).

TABLE 7.—RESULTS OF THE MULTIPLE COMPARISON TEST APPLIED TO THE DIFFERENCES BETWEEN MEANS ON THE TRI-S SCALE FOR ACADEMIC AREA PREFERRED BY STUDENTS AT SELECTED COLLEGES IN KENTUCKY

Categories compared	n	Means	*t*
Humanities majors	202	107.58	3.52[1]
Natural science majors	230	111.77	
Natural science majors	230	111.77	3.91[1]
Social science majors	477	107.85	
Humanities majors	202	107.58	0.26
Social science majors	477	107.85	

[1] Significant at the 0.01 level.

TABLE 8.—ANALYSIS OF VARIANCE FOR VOCATIONAL CHOICE OF STUDENTS AT SELECTED KENTUCKY COLLEGES AS DERIVED BY THE TRI-S AND VGAS SCALES

Scale	Source of variation	Sum of squares	df	Mean square	F
Tri-S	Vocational choice	4,417	2	2,208.50	14.64[1]
	Within	136,631	904	150.81	
VGAS	Vocational choice	288	2	144.00	0.34
	Within	384,000	904	423.84	

[1] Significant at the 0.01 level.

The variability of the scores for the groups responding to the attitude scales was consistent in that the test of the homogeneity of variance failed to produce any significant F ratios. Indications of the dependability of the scores reported in this study may be surmised from the reliability coefficients obtained from the instruments, with respectable values of 0.7853 for the Tri-S and 0.8118 for the VGAS scale.

CONCLUSIONS AND IMPLICATIONS

Possession of sufficient semester hours of course work in science to qualify for a minor or a major was associated with a more positive attitude toward science than was true with students with fewer hours. This could be interpreted in either of 2 ways. Participation in science courses may be contributing toward a more positive attitude, or a preexisting more positive attitude may influence students to enroll in more science courses. Although reassuring to science educators, it would be presumptuous to infer that enrollment in science courses necessarily leads to improved attitudes. Until further research clarifies the situation, all that can be said is that students with a minor or a major in science also have more positive attitudes toward science. Had less positive attitudes been associated with increased course work in science, a much more serious problem would face science educators than occurs with the present situation. When the observed relation between attitudes and course work in science is better understood, and causal relations are determined, programs to improve attitudes of nonscience students will have an enhanced probability of success.

The findings of this study indicate social science and humanities majors, at both small and large institutions, possess less favorable attitudes toward science as a cultural activity of man than do natural science majors. Thus, it would appear that some of the objectives of the general education program are not being achieved. The nonscience student may be acquiring an understanding of science; that has neither been established nor disproved in this study, but it is apparent that all student groups do not exhibit an equally supportive positive attitude toward science. It may be necessary to revise or add to the currently available general education science courses in order to achieve the stated objectives more fully. Verbal and written comments from the subjects of the

TABLE 9.—RESULTS OF THE MULTIPLE COMPARISON TEST APPLIED TO THE DIFFERENCES BETWEEN MEANS ON THE TRI-S SCALE FOR VOCATIONAL CHOICE OF STUDENTS AT SELECTED KENTUCKY COLLEGES

Categories compared	n	Means	*t*
Elementary education	234	105.95	1.85
Secondary education	300	107.89	
Secondary education	300	107.89	3.48[1]
Nonteaching	375	111.26	
Elementary education	234	105.95	5.18[1]
Nonteaching	375	111.26	

TABLE 10.—CORRELATIONS BETWEEN THE ATTITUDE SCALES FOR EACH GROUP AND FOR THE TOTAL SAMPLE OF STUDENTS FROM SELECTED KENTUCKY COLLEGES. ALL CORRELATIONS ARE SIGNIFICANTLY DIFFERENT FROM ZERO AT THE 0.01 LEVEL

Group	n	r	r^2
Small private schools	468	0.3377	0.1140
Large state schools	441	0.3001	0.0901
Males	412	0.3002	0.0902
Females	497	0.3443	0.1185
Zero–7 semester hours of science	266	0.3298	0.1087
8–17 semester hours of science	404	0.3300	0.1089
18 or more semester hours of science	239	0.2981	0.0889
Humanities majors	202	0.3254	0.1058
Natural science majors	230	0.2894	0.0837
Social science majors	477	0.3375	0.1139
Elementary education	234	0.3802	0.1445
Secondary education	300	0.4026	0.1620
Nonteaching	375	0.2408	0.0579
Total	909	0.3221	0.1037

investigation frequently referred to the boring nature of current courses and their lack of relevancy. An increased emphasis on the interrelations of science, technology, and society, and more frequent investigations into contemporary problems seem warranted.

The association between attitudes toward science and the type of institution attended may be due to an inherent difference between students attending state schools and those attending private liberal arts colleges, or it may be an indication of change that occurs while attending one type of institution and not at the other. Either or both of those conditions would seem to offer the best explanation for the observed association since their general education requirements and catalog descriptions do not differ appreciably. Regardless of the source of the difference, an effort should be made to improve student attitudes toward science at the small liberal arts colleges.

One of the most rewarding experiences of this study was the opportunity to establish relations and exchange views with nonscience faculty across the state. It became apparent that members of the various disciplines share many of the same concerns and have the potential to contribute much toward the solution of our common concerns. It would seem advisable to increase contacts and communication across disciplinary lines and among schools if we are to maximize the potential.

In view of their potential contribution to improving attitudes toward science through their future roles in the classroom, the lower attitude scores of prospective teachers, as compared to students not preparing for a teaching carrer, should be regarded with concern. If teachers are to assist others in acquiring or improving existing constructive attitudes, it would seem reasonable that they themselves should first possess those attributes.

It may be worthwhile to undertake curricular revision whereby prospective elementary and secondary teachers participate in special science courses intended to encourage formation of more positive attitudes. Such courses should stress the nature of science, its interrelationship with society, and the contribution of science as a human intellectual activity along with the more conventional process and content objectives. Currently, college faculties in the state have indicated little support for science courses expressly for prospective teachers, but the results of this study indicate present programs to be inadequate.

Regardless of its final form, remedial action is warranted, the nature of which will need to be determined in subsequent research.

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