DOCUMENT RESUME

ED 062 120 SE 013 458

AUTHOR Elliott, Walter E.
TITLE Student Perceptions of College Physics and Physics Teachers.
PUB DATE Feb 72
NOTE 17p.; Paper presented at the American Association of Physics Teachers Annual Meeting, 41st, San Francisco, California, February 1972

EDRS PRICE MF-$0.65 HC-$3.29
DESCRIPTORS *College Science; Comparative Analysis; Evaluation; Mathematics; *Physics; Physics Teachers; *Student Attitudes; Student Characteristics

ABSTRACT

This study sought answers to the question: In what ways were selected attitudes and other characteristics of college physics students related to their perceptions of physics and mathematics courses and of physics and mathematics teachers? The students were those enrolled in all sections of both the calculus and non-calculus oriented, three quarter sequenced, introductory general physics courses offered at California State Polytechnic College during Winter Quarter, 1971. The results indicated that students felt mathematics was more relevant and more palatable than physics. Physics courses were perceived as relatively low in stimulation, personal usefulness, social value, historical value, and political value. The laboratory experiences were described as not exciting intellectually, not personally useful, and not supportive of the lectures. Students who had high school physics held decided perceptual advantages over students who had not had high school physics. (Author/TS)

STUDENT PERCEPTIONS of COLLEGE PHYSICS and PHYSICS TEACHERS

QUANTITATIVE EVIDENCE OF CALIFORNIA
STATE POLYTECHNIC COLLEGE PHYSICS STUDENTS'
PERCEPTIONS OF PHYSICS AND PHYSICS TEACHERS

A paper presented at the
Forty-First Annual Meeting,
American Association of Physics Teachers,
San Francisco, California
on 2 February 1972

by

Walter E. Elliott
Physics Department
California State Polytechnic College
San Luis Obispo, California 93401

TABLE OF CONTENTS

STUDENT PERCEPTIONS OF COLLEGE PHYSICS AND PHYSICS TEACHERS

Foreword

Physics is the most exact and fundamental of the natural sciences.[1] A scientifically terate citizenry appears to be essential if our science-oriented, technology-infused democratic society is to survive. But, paradoxically, in this nation which prides itself on educating for a well-rounded citizen, our high school, college, and university students are avoiding the study of physics![2]

Dr. Bentley Glass, eminent scientist and educator, has discussed the Pandora's box opened by modern science and the consequent need for an understanding of science to combat the evils released.[3] He has pointed out such concomitant evils as: modern medicine's conquest of disease and the resultant population explosion; machines for rapid transit and the accompanying noxious residues which foul the atmosphere and turn sunny lands dark; mushrooming industrial complexes which supply our wants while producing effluents which make the lands stink, the fishes die, and the waters unfit to drink. Glass asks whether or not a modern, democratic civilization can long endure if its populace grows increasingly complacent in its ignorance of science.

Dr. Elmer Hutchisson, past-Director of the American Institute of Physics and currently editor of The Journal of Applied Physics, has emphasized that in addition to the utilitarian considerations there exist purely esthetic and academic reasons why students should want to study physics.

> To be completely illiterate as far as the fundamental work of Galileo or Newton is concerned or in the enormous contributions to society made by physicists such as Maxwell, Einstein, and Bohr is certainly just as great a sin as to be ignorant of the equally great contributions of such men as Plato, Shakespeare, Beethoven or Michelangelo.[4]

If one accepts the interlocking theses that science education is essential to a modern democratic society, that the well-educated citizen ought to have an adequate knowledge of the people and the philosophy and the processes of science, and that physics is the science which is the cornerstone for all of the natural sciences, then one must also accept the conclusion that physics education is truly vital to our youth.

Introduction

Scientists and educators have sounded numerous alarms concerning the negative implications of the nation-wide decline in physics enrollments over the last two decades.[5,6]

And some have speculated that clues to understanding the phenomenon of low enrollments might lie in analysis of the perceptions students hold of physics courses, of physics teachers, of physics as a field of study, and of the life-styles of professional physicists.[7]

A reason cited frequently as to why students avoid physics is that physics is difficult.[8] But mathematics is commonly considered

be a difficult subject, and mathematics has not suffered from similar declining enrollments. Apparently, mathematics is perceived by students to be an essential of education, but physics is not. Accordingly, this study probed college students' perceptions of physics and, to a lesser degree, their perceptions of mathematics.

The Problem

This study sought answers to the question: In what ways were selected attitudes and other characteristics of college physics students related to their perceptions of physics and mathematics courses and of physics and mathematics teachers?

Design of the Study

The normative survey method was used. Students responded anonymously to a 100-item questionnaire by sense-marking IBM computer cards. All responses were of the closed type; respondents had no choices of response to a given questionnaire item other than those which appeared on the questionnaire itself. The IBM response cards were machine-processed and computer-analyzed, and the computer data then interpreted.

The total general physics student population was comprised of all students enrolled in all sections of both the calculus and non-calculus oriented, three-quarter sequenced, introductory general physics courses offered at California State Polytechnic College, San Luis Obispo, during the Winter Quarter, 1971. The population sample consisted of 1108 students, constituting approximately 80% of the total general physics student population.

California State Polytechnic College (hereafter referred to as Cal Poly) is one of the two polytechnic institutions included in the

19 institutions comprising what will be known after March 4, 1972, as the California State University and Colleges. Cal Poly is located at San Luis Obispo, a city of less than 30,000 people. San Luis Obispo is in a rural, low-population density region about midway between Los Angeles and San Francisco. Cal Poly's 12,000 students are enrolled mostly in agriculture, engineering, architecture, and applied arts and sciences. The Physics Department employs nearly 30 full-time teachers, offers no graduate degree, and has approximately 55 full-time undergraduate physics majors.

Findings

The findings were based upon frequency of responses to questionnaire items and upon Chi square tests for significant relationships between selected questionnaire items.

Those findings based upon frequency of responses are presented first; those based upon Chi square tests are presented in a second section.

It should be noted that, because this was a statistical study, the findings are considered suggestive rather than definitive.

Personal characteristics. Table I shows selected characteristics of the physics student respondents. Ninety per cent of the physics students were males; 85% were unmarried; 52% were ages 19-21 years; and 29% were over 21 years of age. One-third of these students were enrolled in the School of Science and Mathematics; 1/3 in the School of Engineering and Technology; and 1/6 in the School of Architecture and Environmental Design. Five per cent of these students reported a cumulative grade point average of A; 21-1/2% reported B; and 66% reported C as their cumulative grade point average.

Scholastic backgrounds. Table II presents selected aspects of the mathematics and physics backgrounds of the physics student respondents. Ninety per cent completed Algebra I in high school; 80% completed Algebra II; and 65% completed high school trigonometry. Nearly one-half of these physics students had completed, or were taking, college algebra; nearly 1/2 had, or were taking, college trigonometry, about 3/4 had, or were taking, college calculus; and about 1/10 of the students had taken, or were taking, college differential equations.

Physics course experiences. Table II shows something of the respondents' physics course experiences. Forty per cent of the college physics students had not taken physics in high school; 40% had taken a traditional high school physics course; 18-1/2% had taken a Physical Sciences Study Committee (PSSC) course in high school; and slightly less than 2% reported having had The Harvard Project Physics (HPP) course in high school. These students were in the first, second, or third quarter of the three-quarter sequenced general physics courses offered at Cal Poly. Of the 61% who had completed at least one quarter of college physics, their cumulative grade point averages for these completed courses were: 7-1/2% A; 18-1/2% B; 30% C; and 5-1/2% D.

Perceptions of physics and mathematics. Physics courses were perceived as moving somewhat faster than mathematics courses. Over 40% of the respondents felt their physics course "moved too fast"; but only 33% felt mathematics courses "moved too fast."

Physics tests put students somewhat more "up tight" than mathematics tests. Approximately 40% felt "very high tension" during a physics test; only 33% felt "very high tension" during a mathematics test.

TABLE I

Characteristics of College Physics Students
(% of respondents, rounded off)

1.	Sex	
	male	90%
	female	10%
2.	Marital status	
	married	85%
	single	15%
3.	Age	
	16-18	19%
	19-21	52%
	22-23	12%
	24-25	7-1/2%
	over 25	9-1/2%
4.	School	
	Agriculture & Natural Resources	5-1/2%
	Architecture & Environmental Design	18-1/2%
	Business & Social Science	1%
	Communicative Arts & Humanities	less than 1/2%
	Engineering & Technology	38%
	Human Development & Education	1-1/2%
	Science & Mathematics	34%
5.	Cumulative grade point averages	
	A	5%
	B	21-1/2%
	C	66%
	D	6-1/2%

TABLE II

Students' Backgrounds in Physics and Mathematics
(% of respondents, rounded off)

1. High school math courses	
Algebra I	90%
Algebra II	80%
Trigonometry	65%
2. College math courses (completed or currently enrolled)	
Algebra	43%
Trigonometry	48%
Calculus	70%
Differential equations	13-1/2%
3. Kind of high school physics course	
PSSC	18-1/2%
Harvard Project	less than 2%
Traditional	40%
none	40%
4. Cumulative college physics course(s) grade point average	
A	7-1/2%
B	18-1/2%
C	30%
D	5-1/2%
none (currently enrolled in first physics course)	39%

Twice as many students indicated they enrolled in mathematics because they were "just interested," than indicated they enrolled in physics for the same reason. Eighty per cent of the students enrolled in physics because it was required for their major; only 13% enrolled in physics because they were "just interested."

Nearly 40% felt they would do better in physics if their mathematics backgrounds were better.

One-third more students expressed interest in a credit-no credit option for courses other than physics, than for physics courses. One-third indicated they would enroll in a physics course, even if it were not required for their major, if they could take the course on a credit-no credit basis.

Students' responses indicated that they were more "stimulated" by mathematics courses than by physics courses. Further, they perceived their mathematics courses to be significantly more "useful in life" than their physics courses.

Students indicated that their mathematics lectures and their physics lectures presented about the same degree of difficulty.

Physics teachers were perceived as being slightly less interested in students, and in students' personal problems, than were the mathematics teachers.

Physics laboratory experiences were ranked low by the students in terms of stimulation, "usefulness in life," and the extent to which they supplemented and clarified the lectures.

The difficulty of physics was reported as "very much" by 40% of those polled.

Physics was ranked low in stimulation by 39% of the physics students, and low in "personal usefulness" by 37%.

The "social value" of physics courses was ranked "below average" by 34%, and as "none" by 40%; the "political value" of these courses was ranked "below average" by 30%, and as "none" by 60%; and the "historical value" was ranked "below average" by 32%, and as "none" by 33%. In contrast, the scientific value of their physics courses was ranked as "very much" by 59% of the students.

Perceptions of school and self. Of the Cal Poly physics students polled, one in three responded that they liked school "very much," and fewer than one in six liked school "not at all" or "less than average." Over 40% worried "very much" about getting good grades; 32% tried "very much" to get the most from a course; and 25-1/2% reported "very much" self confidence as students. One of every five students indicated "very much" fear of asking a question in class because it might appear to be a "dumb" one (This question was not asked in reference to physics classes, but with reference to asking a question in any class.).

Findings based upon Chi square analyses are presented in this second section; the confidence level is given parenthetically after each item correlated.

Correlates of high school physics backgrounds. Significant relationships were established between selected questionnaire items and the high school physics backgrounds of the respondents.

Students who had studied PSSC (.001) or traditional high school physics (.001) "liked physics" to a significantly greater extent than did those students who had not studied physics in high school.*

*The HPP sample was too small for Chi square testing.

A significantly greater number of students who studied PSSC physics (.001) or HPP physics (.001) enrolled in a college physics course just because they were interested, than did students who had not studied physics in high school.

Significantly more students who had a traditional high school physics course indicated that they would take physics as an elective on a credit-no credit basis even if it were not required for their major, than did students who had not studied physics in high school.

Students who studied no physics in high school felt significantly greater tension during a physics test than did those who had traditional high school physics (.01) or PSSC physics (.001).*

Students from traditional high school physics courses indicated a significantly greater preference for conventional tests and for open-book tests, but a lesser preference for oral tests, than did students who had taken no high school physics (.05).

Students with a background of PSSC (.001), HPP (.001), or traditional (.05) high school physics felt to a significantly lesser extent that their college physics course moved "too fast," than did students who had no background of high school physics.

Students who felt more strongly that physics was "difficult":

(a) indicated a greater confidence in their teachers' knowledge of physics (.01)

(b) felt more strongly that physics teachers understood their school-related problems (.01)

(c) reported significantly higher cumulative college physics grade point averages (.01)

---

*The HPP sample was too small for Chi square testing.

Students who felt more strongly that physics was "personally useful in life":

(a) had teachers whom they perceived as enjoying teaching physics to a significantly greater degree than did those who low-rated the personal usefulness of physics (.01)

(b) indicated a significantly greater confidence in their teachers' knowledge of physics (.01)

(c) felt more strongly that their physics teachers were interested in them "as a student" (.01)

(d) felt their physics teachers better understood their school-related problems (.01)

(e) reported significantly higher cumulative college physics grade point averages.

Students who felt more strongly that their physics courses lacked social value:

(a) perceived their physics teachers as little understanding their school-related problems (.01)

(b) felt their physics teachers were not as much interested in them "as a student" (.01)

(c) reported less confidence in their teachers' knowledge of physics (.01).

Summary, Conclusions, and Recommendations

Summary of the Problem. The student appeal or "drawing power" of physics courses in the secondary schools, the colleges, and the universities has declined over the last two decades. This steady decline has emphasized dramatically that although physics is the cornerstone for all the natural sciences, the swing away from physics courses is an entrenched phenomenon.

When so many young people avoid physics courses while ostensibly preparing themselves for living in a world whose very survival depends upon sound decisions about scientific problems it is time to closely examine the attitudes and perceptions students hold of

physics and physics teachers. With greater insight into these perceptions, perhaps physics courses can be reconstructed so as to be more competitive in the education market.

Summary of the Findings. This study corroborated that most physics students were "captives," taking physics courses required for their particular academic majors. Physics courses attacted few women, and were not as well-liked as mathematics courses. Although mathematics and physics were perceived as affording about the same degree of difficulty, twice as many students enrolled in mathematics courses because of personal interest as enrolled in physics courses for the same reason. To these students mathematics possibly appeared to be more relevant and more palatable than physics.

Physics courses were perceived as relatively low in stimulation, personal usefulness, social value, historical value, and political value. Physics laboratory experiences failed to "turn on" roughly one-half of all the respondents, who low-rated their laboratory experiences as not exciting intellectually, not personally useful in life, and not supportive of the lectures.

Students who studied high school physics before enrolling in college physics courses held decided perceptual advantages over the non-high school physics students in terms of feeling a greater interest in physics, feeling better able to keep up with the pace of college physics courses, liking physics more, and experiencing less tension during physics tests.

Recommendations of the Study. Students appear to learn efficiently when they feel a need to know that which is to be learned; to discover some personal meaning for that which they have learned; to apply that which they have learned to some greater cognitive whole;

and, to master a few key, unifying concepts rather than an aggregate of facts. In keeping with these learning concepts, and in light of what the students have told us in this study, the following recommendations seem appropriate:

(a) Students who plan on taking a college physics course should study physics in high school.

(b) Because the difficulty of physics did not appear to be the dominant factor in student perceptions, it should be possible to reconstruct physics courses so as to provide broader student appeal in terms of stimulation, interest, personal usefulness, social value, political value, and historical value.

(c) Special emphasis should be put upon the inclusion of physics course objectives having stronger appeal to girls.

(d) Laboratory experiences should be planned so as to excite more students intellectually, to appear more useful to more students, and to be more supportive of the lectures in terms of supplementing and clarifying them.

(e) Physics teachers should make concerted efforts to "sell" physics to students and to "humanize" it more; i.e. enhance the perceived social, historical, and political values of physics and its perceived personal usefulness to the students.

(f) Physics teachers should familiarize themselves with the concepts and rationale of Mager's Developing Attitude Toward Learning,[9] so as to teach more positive attitudes toward science in general and toward physics in particular.

(g) Physics teachers should state more course objectives in performance terms. This implies that students need to know in advance what the instructional objectives of the course are, the conditions under which they must demonstrate mastery of these objectives, and the levels of performance required for a given mark in the course. Teachers ought thus to become familiar with such approaches as those set forth in Mager's Preparing Instructional Objectives,[10] and to use such performance objectives as a matrix from which student appreciation and understanding of the nature of physics can be generated.

Closing Comments. We live with the paradox of unemployed physicists walking the streets, scarcely able to communicate with even the intelligent layman, who remains relatively ignorant of science although forced almost daily to make the science-based decisions thrust upon him by the very

nature of our technological society. Might we not fill our empty physics classrooms and employ our job-seeking physicists, if we offered courses specifically designed to encourage people to gratify their scientific curiosities and specifically designed to compete in the "seller's market for special courses that appeal to the deeply ingrained (although often unnurtured) interest of the intelligent layman in the natural sciences."?[11]

References

1. Brauer, Oscar L., "Attempts to Improve High School Physics Education," Science Education, vol. 47, no. 4 (October, 1963) pp. 372-376.

2. Holton, Gerald, "Harvard Project Physics," Physics Today, vol. 20, no. 3 (March, 1967), pp. 31-34.

3. Glass, Bentley, "The Scientist and the Science Teacher," AAUP Bulletin (Sept., 1964), pp. 123-124.

4. Hutchisson, Elmer, "Physics in our High School - A National Problem," The Physics Teacher (Nov., 1964), pp. 385-386.

5. Haber-Schaim, Uri, "The PSSC Course," Physics Today, vol. 20, no. 3 (March, 1967), pp. 26-31.

6. Gatewood, Claude W., "Improving Science Education in the United States," Journal of Research in Science Teaching, vol. 1 (1963), pp. 355-399.

7. Elliott, Walter E., "Perceptions of High School Physics and Physics Teachers," The Physics Teacher, vol. 9, no. 1 (January, 1971), pp. 33-36.

8. Jennings, James B., "Selling Physics," The Physics Teacher, (October, 1968), p. 366.

9. Mager, Robert F., Developing Attitude Toward Learning, Belmont, California, Fearon Publishers/Lear Sigler, Inc., 1968.

10. Mager, Robert F., Preparing Instructional Objectives, Belmont, California, Fearon Publishers/Lear Sigler, Inc., 196[illegible]

11. Davis, Harold L., "Teaching Physics in the Corridors," Physics Today, vol. 24, no. 8 (Aug., 1971), p. 88.