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# THE LABORS OF HERCULES OR THE PATIENCE OF PENELOPE?

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**President IAS, 1989**
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Ernest E. Campaigne, in his Presidential Address of 1986 titled "Quo Vadis or If Nobody Does Anything, Nothing Will Be Done," presented the members of the Indiana Academy of Science with a series of questions. What has happened since that time? Have the members of the Academy performed labors worthy of Hercules — or have they waited with great patience for the answers to be provided by others? Answers to Dr. Campaigne's questions have provided new questions. These new questions focus on the needs and status of science education in the United States and especially in Indiana. Once again, the Academy is challenged, "Quo Vadis?"

Hercules was the son of Jupiter and a mortal woman; consequently, in a fit of rage and in order to punish Hercules, Juno (the wife of Jupiter) arranged for Hercules to perform twelve nearly impossible labors. In the 1986 presidential address, Ernest E. Campaigne asked, "Quo Vadis?" In this address, he stated that ". . . the Indiana Academy of Science should strive to enlarge its role in the transfer of knowledge." He continued by raising some questions which he indicated needed answers. Dr. Campaigne's clear-sighted assessment of Academy concerns has guided the Academy thinking for several years; I relate his challenges to the labors of Hercules.

The *Proceedings* were the focus of Dr. Campaigne's first questions. He suggested advantages and disadvantages of publishing the abstracts before the annual fall meeting and the establishment of a quarterly publication rather than the current annual tome.

The abstracts were first published *before* the meeting in 1986. Since that time, the *Program and Abstracts* booklet has enabled each member of the Academy to review the topics of the presentations and to select those most interesting before attending the meeting. The preparation of this publication has added greatly to the responsibilities of the local program committee.

Following careful consideration by the appropriate committees, another of Dr.Campaigne's recommendations will be implemented; 1990 will be the year the Academy will change to a quarterly publication of research papers.

The second issue discussed by President Campaigne was the frequency of the *Newsletter*. A period of more than one year, beginning shortly after the 1987 fall meeting, intervened between issues of the *Newsletter*. However, during this past year, the *Newsletter* has evolved, under the editorship of Gene Kritsky, as a valuable communication vehicle. The *Newsletter* is attractive, timely, and an important means of permitting the membership to be apprised of the status of the Academy. At this time, the *Newsletter* is published four times a year, providing information at strategic times. President Campaigne suggested publication six times a year; however, currently, this is not possible.

President Campaigne suggested that the annual meetings needed improvement. Since 1986, one major change has occurred; the Symposia have been scheduled at other dates in centralized locations. The Symposia have been planned by the Science and Society Committee; topics of interest to several Academy sections and to the general public have been presented.

The costs of the regular meetings have risen annually — in part, due to publication and distribution of the *Program and Abstracts* booklet and also, due to inflationary increases. The fall registration fee has remained unchanged for years; perhaps this fee should be increased soon to help defray the rising costs of this meeting.

The Invitations Committee has been very active this year. Meeting sites have been identified for the next three years. Quite recently, with the advice of the Executive Committee, I established an ad hoc Programs and Invitations Committee; this committee consists of a group of individuals who have served as local program chairs and/or members of the Invitations Committee. The purpose of this committee is to provide experienced advice, as needed, to Local Program Committees and to perform the functions of the Invitations Committee.

Recruitment of new professional scientist and corporate members is proceeding slowly; patience and persistence are the answer. This year a public relations firm has begun the slow process of making the Indiana Academy of Science more widely known. As part of this effort, each member of the Academy and all members of the General Assembly have received *Science Notes*. The Academy was honored by a proclamation from Governor Bayh declaring the week of November 6, 1989, "Indiana Academy of Science Week."

President Campaigne identified a need for a headquarters office, centrally located, near state government offices. He also suggested that an Executive Secretary is a necessity.

This year the Academy has arranged for Donald Winslow to assume the office of Executive Liaison Officer. As with any new endeavor, the functions of this office are evolving slowly; however, there has been improvement in some services of the Academy which may not yet be obvious to the members, but have already been valuable to the Executive Committee and the committee chairs.

Patience is the word which must be applied to the problem of establishment of a central office. President-elect Wendell McBurney has been busy working with an ad hoc committee investigating this project. Unlike Penelope, who waited 20 years for her husband Ulysses to return from the Trojan War, the Academy should receive definitive news about the establishment of a central office in 1990.

"Can we do more in the field of science education?" asked President Campaigne. The *Constitution* of the Academy clearly states that one of the objectives of the Academy is to improve education in the sciences. President Campaigne noted that "Our Youth Activities Committee is one of the most important committees of the Academy. They are doing a good job under difficult circumstances." I concur with this opinion. The directors and advisory committees of the various activities — whether the Indiana Science Talent Search, the Indiana Science Fairs, the Indiana Junior Academy of Science, Science Research Grants, or the Science Olympiad — are responsible for planning and implementing specific programs and for soliciting funds to augment the monies provided by the Academy treasury.

Planning each Youth Activities program is a big job. Teachers must be contacted, student projects must be solicited, local arrangements must be made, and volunteers to judge the student efforts must be found. The size of the effort depends upon the number of students involved. Last March when I attended the Science Olympiad, nearly 100 teachers, parents, and college students were involved in the operation of the program. That is a large number of volunteers!

When the need for obtaining funds is added to the aforementioned responsibilities, the Academy places an almost impossible task on the event director. Further, this creates another problem — directors of these activities must seek funds in the name of the Academy. Thus, many people contact business and industry for money in the name of the Academy; this is an unfortunate situation! The Academy must consider the possibility of assuming the total expense of a youth activity. In all probability, this will necessitate the establishment of a Youth Activities Fund — a fund which will relieve the directors of the various youth activities of the onerous task of fund raising.

As the first Academy president representing the Science Education Section, I have become aware of the many concerns and opinions of Academy members regarding instruction in science. What are these concerns?

1. Students are not motivated to study science; thus, few students pursue science as a career.
2. Students entering college are poorly prepared in science, pre-college science curricula are not appropriate, and pre-college students are not receiving adequate instruction in science.

I have become very concerned about the status of science education as perceived by the public and by scientists. It is generally accepted that science and science education professionals have two tasks: 1) replacing and augmenting the number of science professionals and 2) preparing teachers who will endeavor to produce a scientifically literate citizenry.

Historically, in the United States, the British were the source of irritation; a revolution resulted. Then in order, Americans vented their frustrations on the Indians, the Irish, the Catholics, the Jews, and now — the educators, or more specifically the teachers? Does this statement shock you? I hope it does! I want your attention! Pre-college education has become the new "scapegoat." Teachers have become the new "whipping boys." I am afraid that "Teacher Bashing" may become the new number one sport.

In order to discuss this dilemma, I felt that I needed to consult data regarding students and science curricula. In this effort, I was assisted by Mrs. Anna R. Carson, Assistant Director, University Testing Office, Indiana State University, Terre Haute. (She collected an inordinate amount of data for the nation, but was not able to obtain

Table 1. High School Graduates—1986 to 2004

| Year | National Count | % of 1986 | Indiana Count | %of 1986 |
|---|---|---|---|---|
| 1986 | 2,650,442 | 10.0% | 65,230 | 100.0% |
| 1987 | 2,695,102 | 101.7% | 67,752 | 103.9% |
| 1988 | 2,768,189 | 104.4% | 69,936 | 107.2% |
| 1989 | 2,732,584 | 103.1% | 70,136 | 107.5% |
| 1990 | 2,594,438 | 97.9% | 67,281 | 103.1% |
| 1991 | 2,474,032 | 93.3% | 63,746 | 97.7% |
| 1992 | 2,441,054 | 92.1% | 61,219 | 93.9% |
| 1993 | 2,449,905 | 92.4% | 61,500 | 94.3% |
| 1994 | 2,445,829 | 92.3% | 59,753 | 91.6% |
| 1995 | 2,548,139 | 96.1% | 61,534 | 94.3% |
| 1996 | 2,580,565 | 97.4% | 62,017 | 95.1% |
| 1997 | 2,673,180 | 100.9% | 62,262 | 95.4% |
| 1998 | 2,777,149 | 104.8% | 64,444 | 98.8% |
| 1999 | 2,786,228 | 105.1% | 61,676 | 94.6% |
| 2000 | 2,823,928 | 106.5% | 61,124 | 93.7% |
| 2001 | 2,790,373 | 105.3% | 58,855 | 90.2% |
| 2002 | 2,823,872 | 106.5% | 58,205 | 89.2% |
| 2003 | 2,905,226 | 109.6% | 58,966 | 90.4% |
| 2004 | 2,912,094 | 109.9% | 57,757 | 88.5% |

Source: *High School Graduates: Projections by State, 1986 to 2004*. Western Interstate Commission for Higher Education, The College Board and Teachers Insurance and Annuity Association, 1988.

data for Indiana in many instances. *Most of the available data relate to education in general, not to science or science education.* Where possible, the data for Indiana in the same year are also included.) As a result of her assistance, I have developed an "information overload." If I were a computer disk, I probably would crash.

## *PRE-COLLEGE STUDENTS —* WHAT ARE SOME OF THE PERTINENT FACTS?

The following table (Table 1) and graph (Figure 1) for the number of high school graduates are based on current data and predictors which seem valid up through the year 2004; the number of Indiana graduates is compared with similarly predicted data for the entire United States. Until the year 1998, the graph representing the number of Indiana graduates parallels that of the United States; by the year 2004, the graph representing the predicted number of graduates for Indiana as compared to that for the United States will have plunged.

Figure 2 shows the percent of projected change in the number of high school graduates, by state, over the next decade. Indiana, like other farming and industrialized states, will experience a decrease in percent of graduates.

A report from the Office of Technology Assessment (OTA) suggests, "All scientists and engineers were once children. Families, communities, and the ideas and images presented by books, magazines, and television helped form their attitudes, encouraged their interests, and guided them to their careers." Figure 3 compares the educational attainment of adults in Indiana with the attainment of adults in the United States in 1987. Although the percentage of high school graduates in Indiana exceeds that in the United States, the percentage of those Indiana adult residents having experienced college

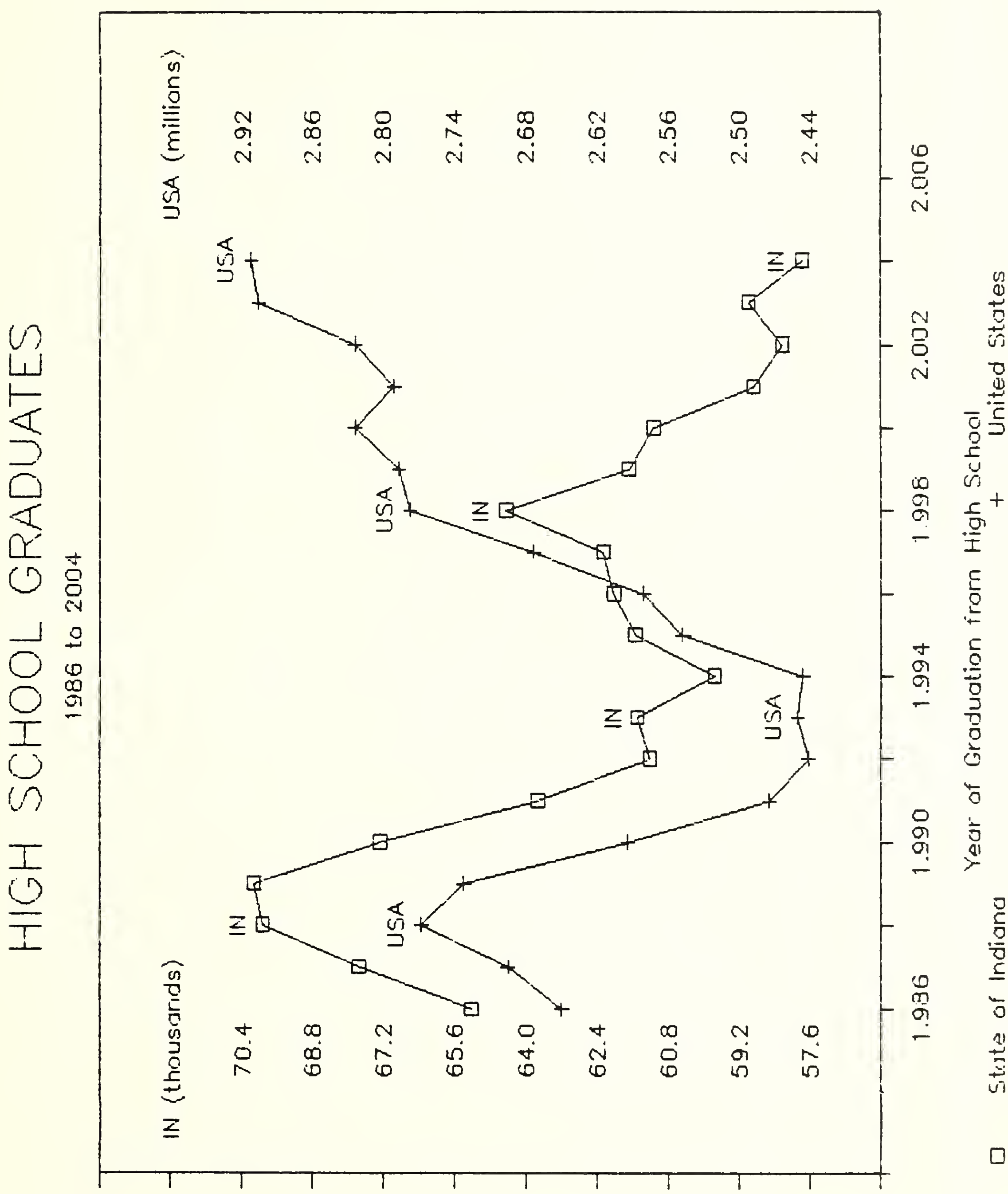

HIGH SCHOOL GRADUATES
1986 to 2004
IN (thousands)
USA (millions)
70.4
68.8
67.2
65.6
64.0
62.4
60.8
59.2
57.6
2.92
2.86
2.80
2.74
2.68
2.62
2.56
2.50
2.44
IN
USA
1.986
1.990
1.994
1.998
2.002
2.006
Year of Graduation from High School
State of Indiana
United States

**Figure 1**

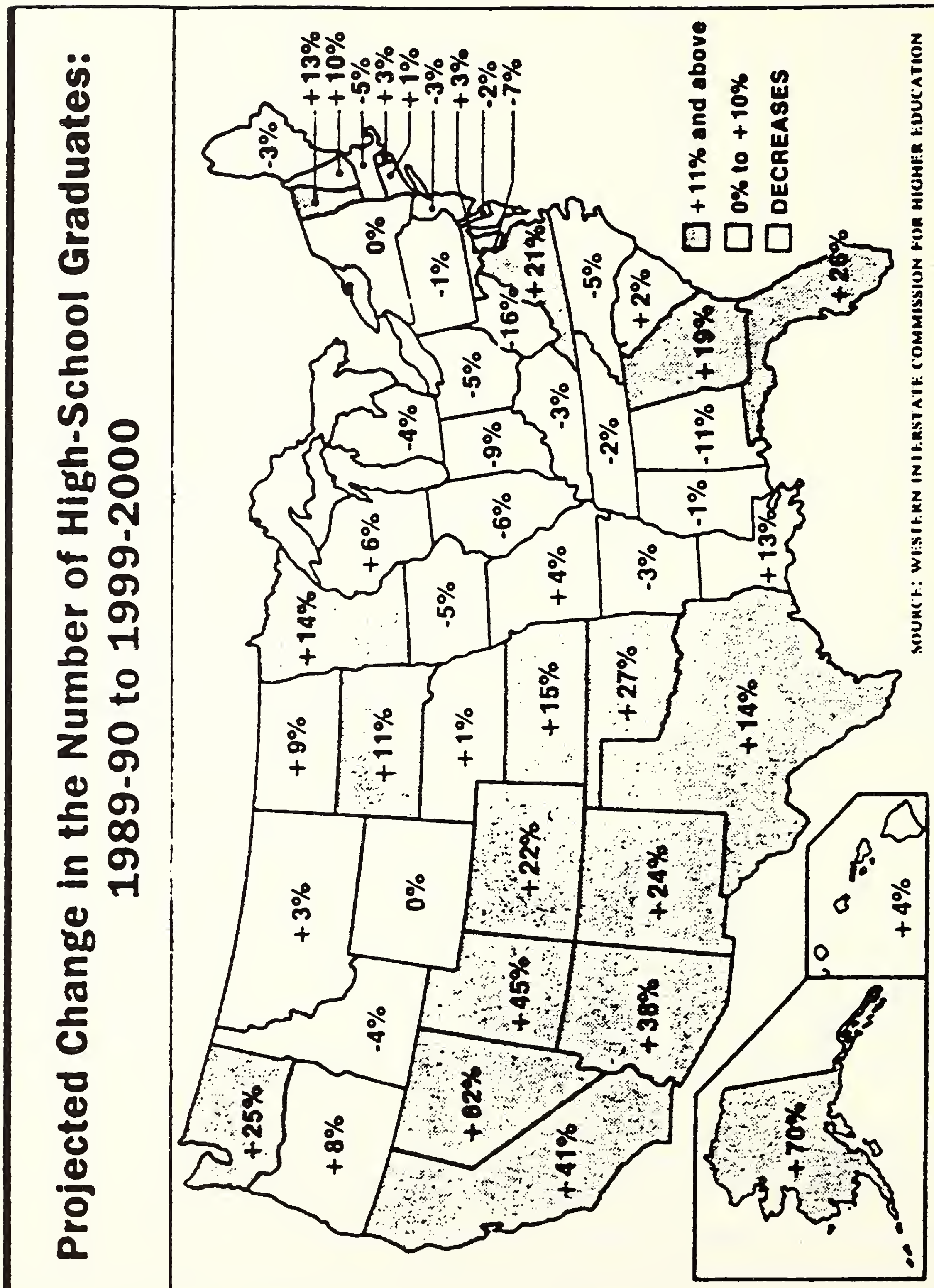
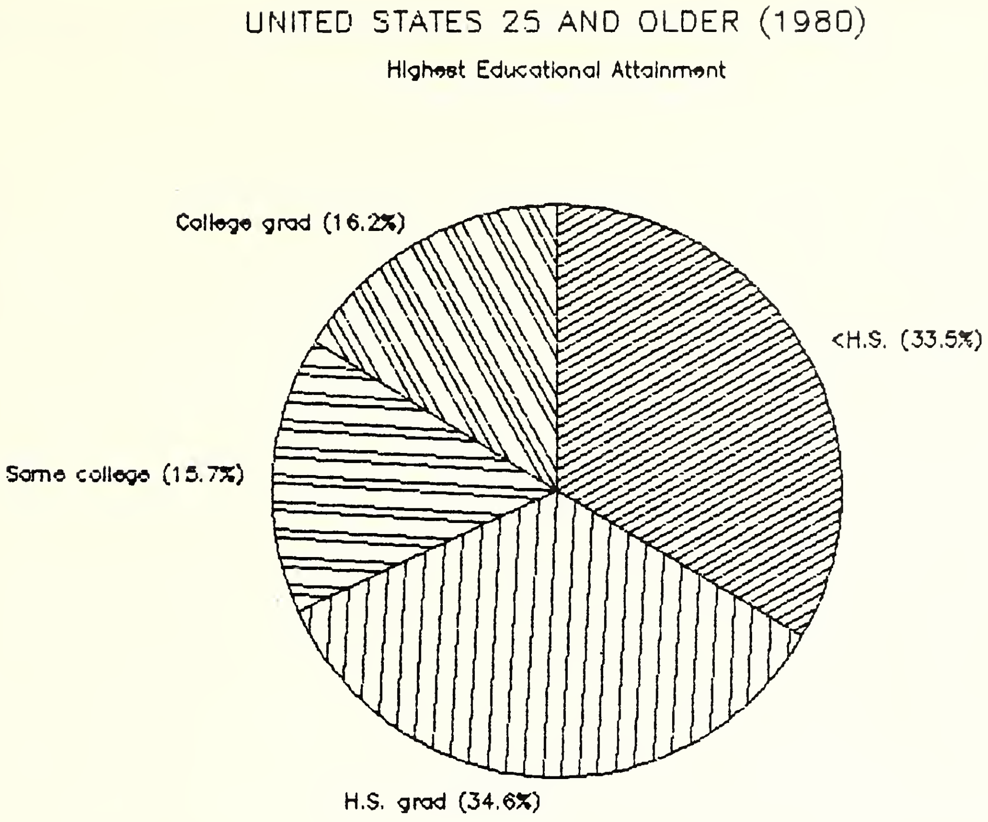

Projected Change in the Number of High-School Graduates:
1989-90 to 1999-2000
+11% and above
0% to +10%
DECREASES
SOURCE: WESTERN INTERSTATE COMMISSION FOR HIGHER EDUCATION

Figure 2


UNITED STATES 25 AND OLDER (1980)
Highest Educational Attainment
College grad (16.2%)
<H.S. (33.5%)
Some college (15.7%)
H.S. grad (34.6%)

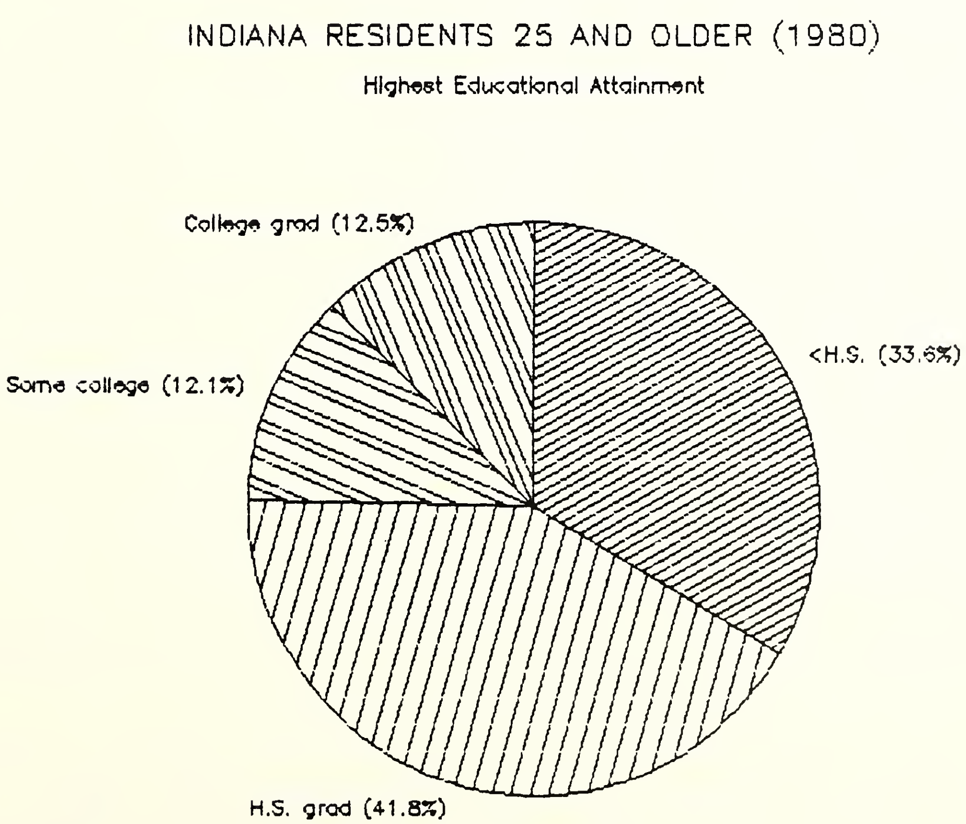

INDIANA RESIDENTS 25 AND OLDER (1980)
Highest Educational Attainment
College grad (12.5%)
<H.S. (33.6%)
Some college (12.1%)
H.S. grad (41.8%)

**Figure 3**

falls short of the national level. The OTA report also indicated, "Schools refined their [the children's] talents and interests, prepared them academically, and gave them confidence by recognizing their aptitude and achievement."

The Office of Technology Assessment report, in comparing the numbers of students entering science and engineering careers, has visualized these career pathways as a pipeline. The report continues, "The science and engineering talent pool is not fixed either in elementary or in secondary school. . . . Students enter the pipeline as early as third grade, . . . . Few, it is generally thought, enter the pipeline after junior high school. In fact, students' intentions remain volatile until well past high school with substantial numbers entering the pipeline (by choosing science and engineering majors) by their sophomore year of college. Many late entrants are relatively ill prepared, . . . ." Figure 4 provides a comparison, by state, of the percentage of the adult populations with four or more years of college experience in 1980. It seems evident that in 1980, Indiana was not far different from other states.

Figure 5 provides the Indiana data related to the number of high school graduates for 1987. Figure 6 presents the percentage of high school dropouts, by state, in 1987. In recent years, the number of dropouts who earned a GED has increased. These individuals may constitute a significant portion of a college student body, many of them full-time students. Throughout the nation, the percentage of first-time college students, enrolled in their home states in 1986, is high (Figure 7). Moreover, in 1987, in many states including Indiana, more than half of the college students were enrolled full-time (Figure 8).

Figures 9, 10, and 11 indicate the data for percentage change in college enrollment for the previous decade, the share of the total college enrollments for each state, and the number of colleges and universities in each state. A brief review of these data clearly shows that Indiana has had an increase in the percentage of college enrollments in the 78 institutions of higher education. In 1987, the population of Indiana was approximately 2.3% of the total population of the United States; thus, the state's 2% share of college enrollment in 1987, does not seem to indicate an exceptionally disproportionate share.

The Office of Technology Assessment noted, "To the Committee (the President's Science Advisory Committee), enhancing our manpower supply is primarily a matter of quality not quantity, not a matter of diverting more college students to science and engineering, but of providing for more students who have chosen this career route the opportunity to continue their studies." The report continued, "Males and females appear to differ strongly in their interest in highly quantitative sciences." However, "There is no evidence that the rate of learning of mathematics by males and females is different" and ". . . women and some racial and ethnic minorities . . . represent a large reservoir of untapped talent."

The OTA stressed that the "in-migrants" to science and engineering majors have taken fewer mathematics and science courses and stated that the challenge of preparing future scientists and engineers is a willingness to bring new entrants to the pipeline "up to speed." The report continued, "If schools were more generous in identifying talent, and urged college-preparatory mathematics and science courses on more students . . . both the size and quality of the talent pool would be improved."

Bill Aldridge, Executive Director of the National Science Teachers Association, in the report "Essential Changes in Secondary School Science: Scope, Sequence, and Coordination" indicated that the number of persons entering scientific and engineering careers is, at present, about five percent of all students. He continued that the recent

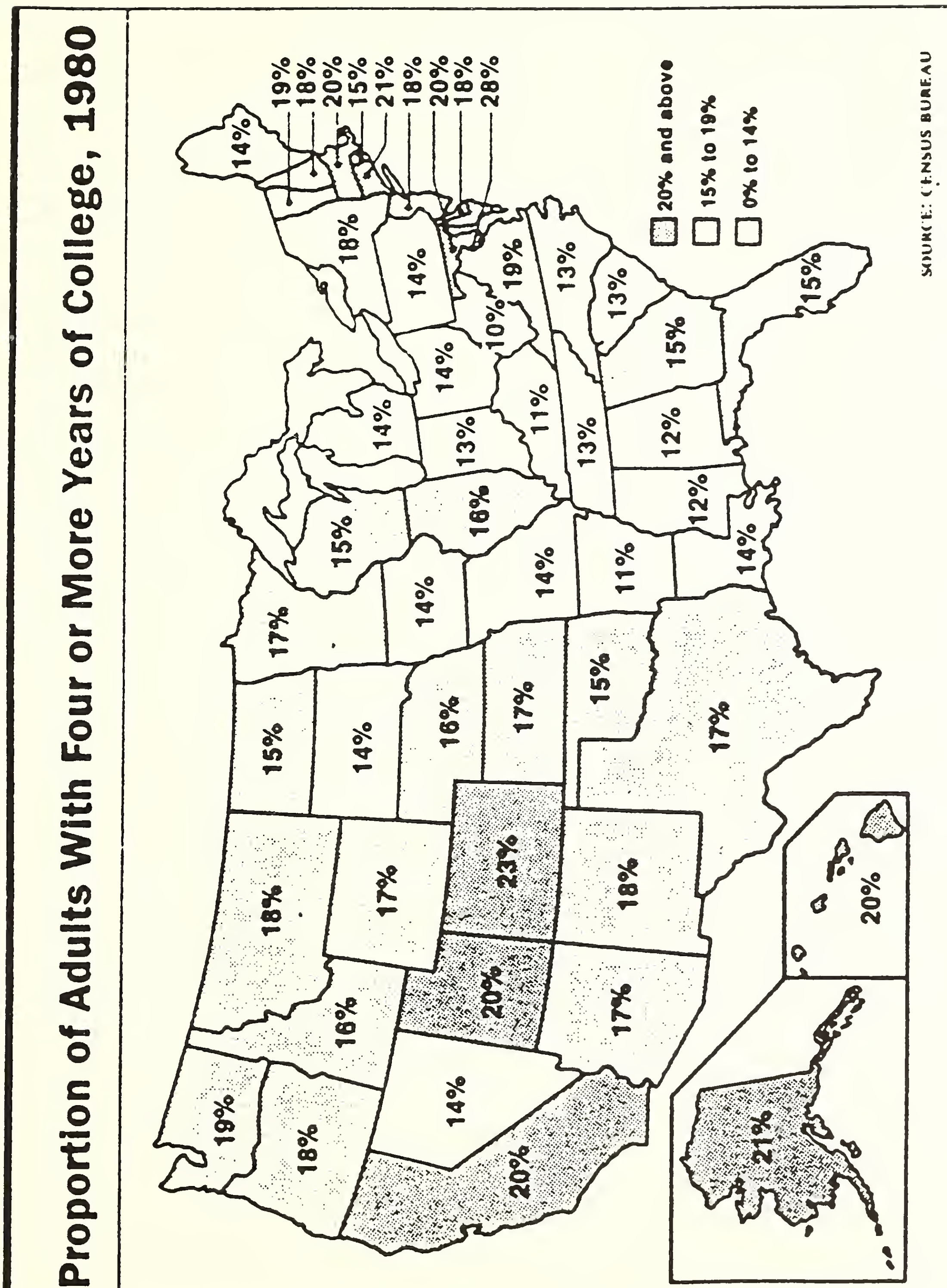

Proportion of Adults With Four or More Years of College, 1980
20% and above
15% to 19%
0% to 14%
SOURCE: CENSUS BUREAU

Figure 4

INDIANA

| | |
|---|---|
| HIGH SCHOOL GRADUATES 1987 | 65,172 |
| HIGH SCHOOL GRADUATES BY GED 1987 | 7,171 |
| FIRST-TIME COLLEGE STUDENTS 1987 | 50,420 |

Figure 5

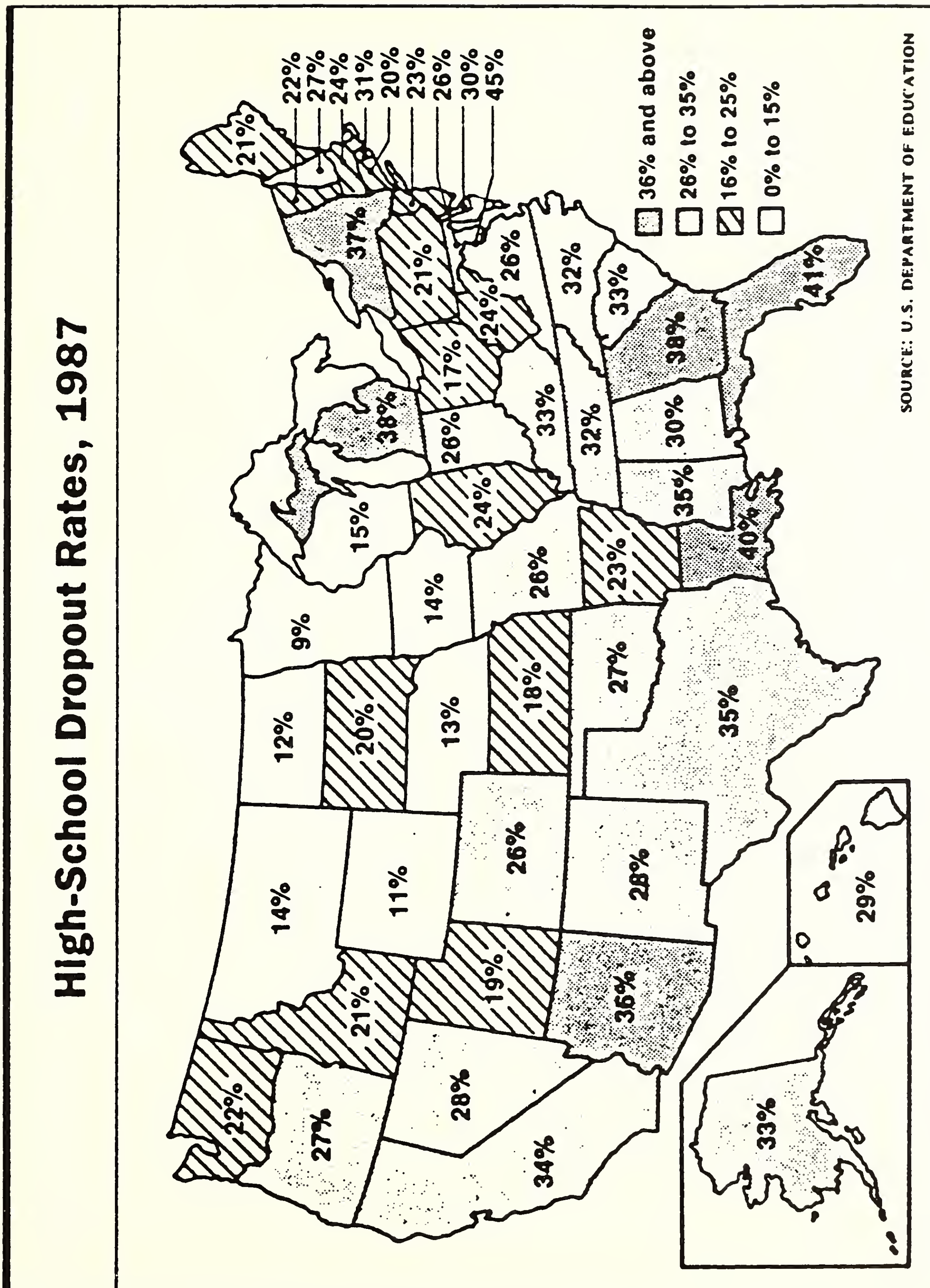

High-School Dropout Rates, 1987
36% and above
26% to 35%
16% to 25%
0% to 15%
SOURCE: U.S. DEPARTMENT OF EDUCATION

Figure 6

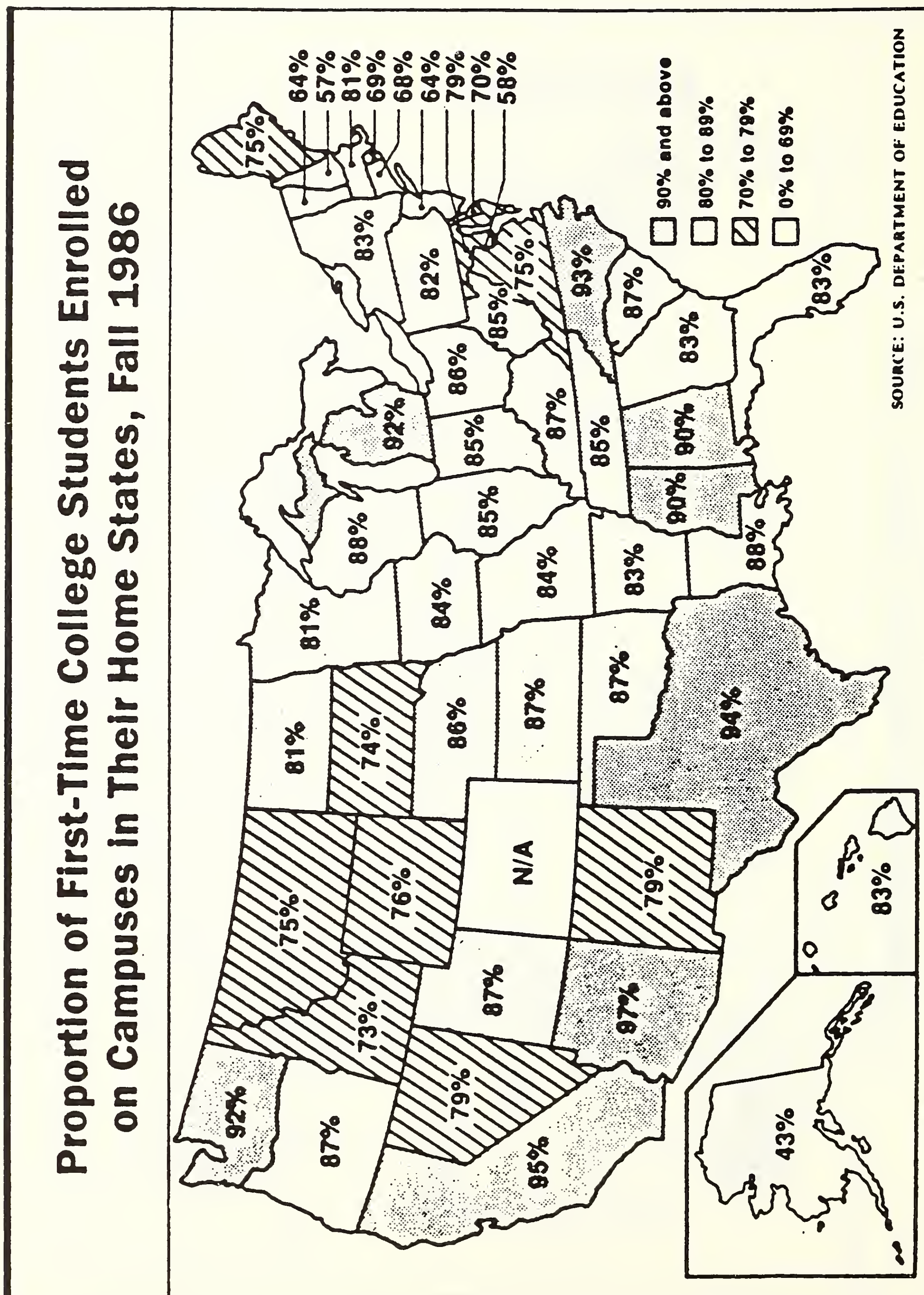

Proportion of First-Time College Students Enrolled on Campuses in Their Home States, Fall 1986
90% and above
80% to 89%
70% to 79%
0% to 69%
SOURCE: U.S. DEPARTMENT OF EDUCATION

Figure 7

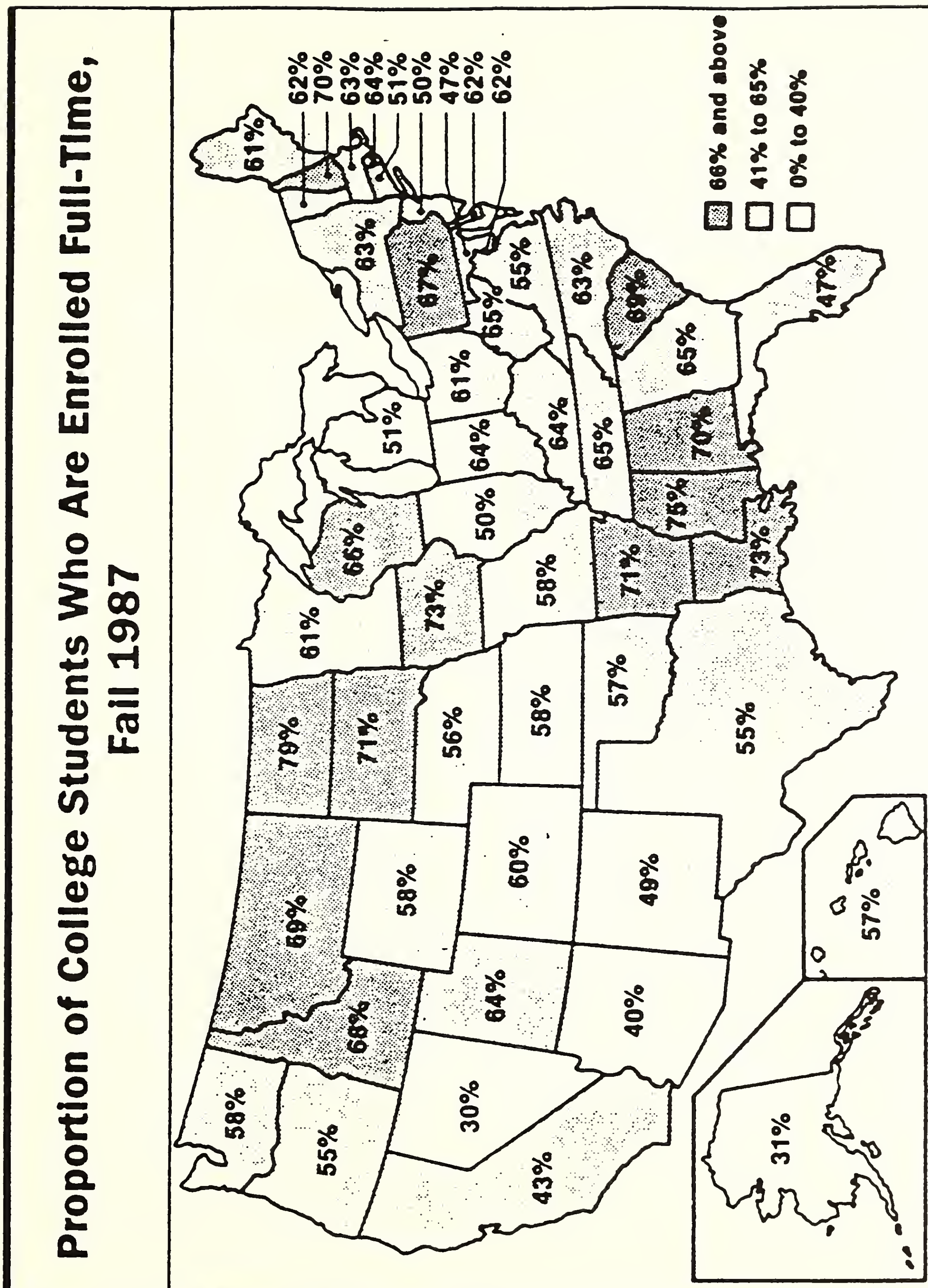

Proportion of College Students Who Are Enrolled Full-Time,
Fall 1987
62%
70%
63%
64%
51%
50%
47%
62%
62%
61%
63%
67%
55%
65%
63%
69%
65%
47%
61%
51%
64%
64%
65%
70%
66%
50%
75%
73%
71%
58%
73%
61%
79%
71%
56%
58%
57%
55%
58%
60%
49%
57%
69%
68%
64%
40%
58%
55%
30%
43%
31%
66% and above
41% to 65%
0% to 40%

Figure 8

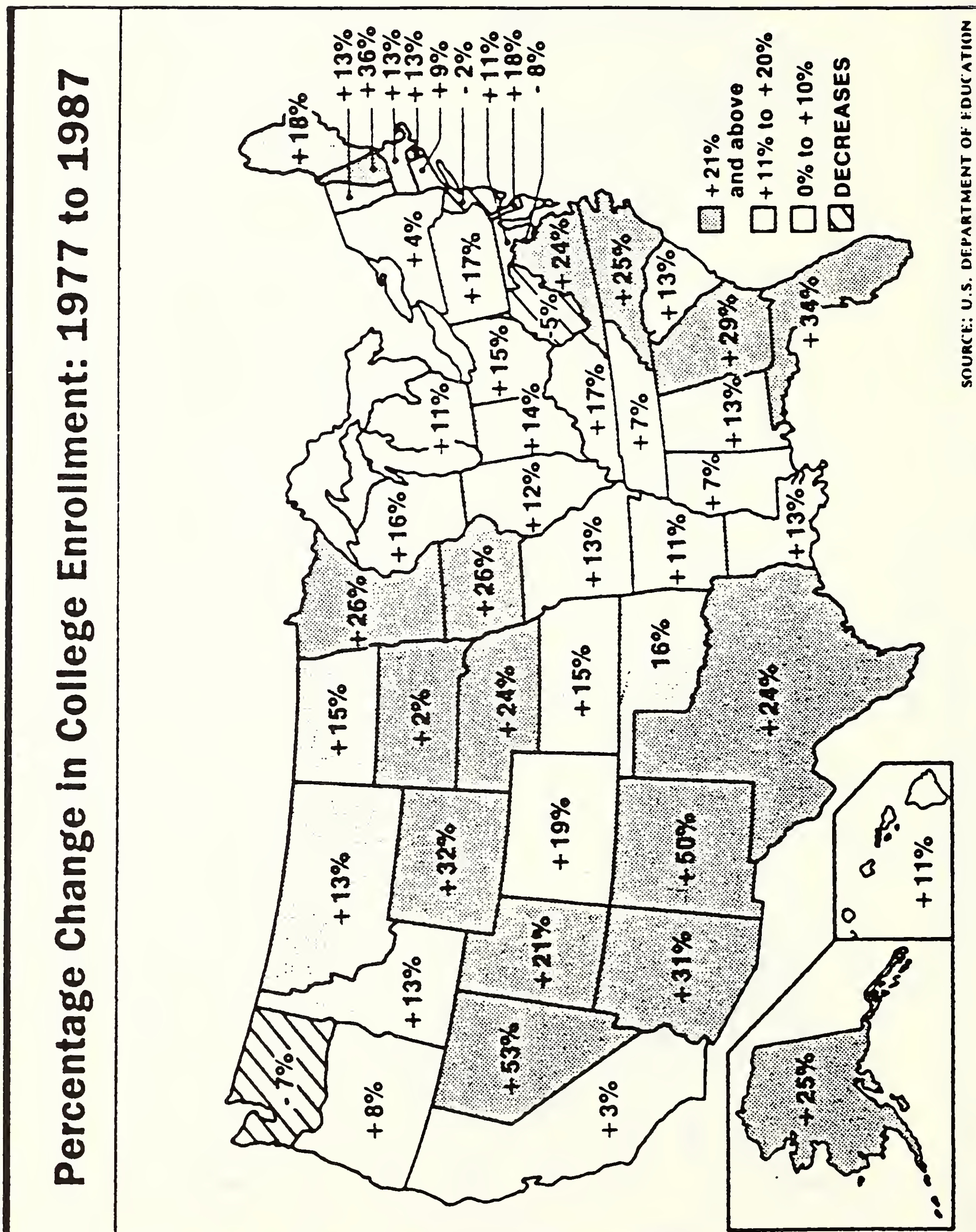

Percentage Change in College Enrollment: 1977 to 1987
+21% and above
+11% to +20%
0% to +10%
DECREASES
SOURCE: U.S. DEPARTMENT OF EDUCATION

Figure 9

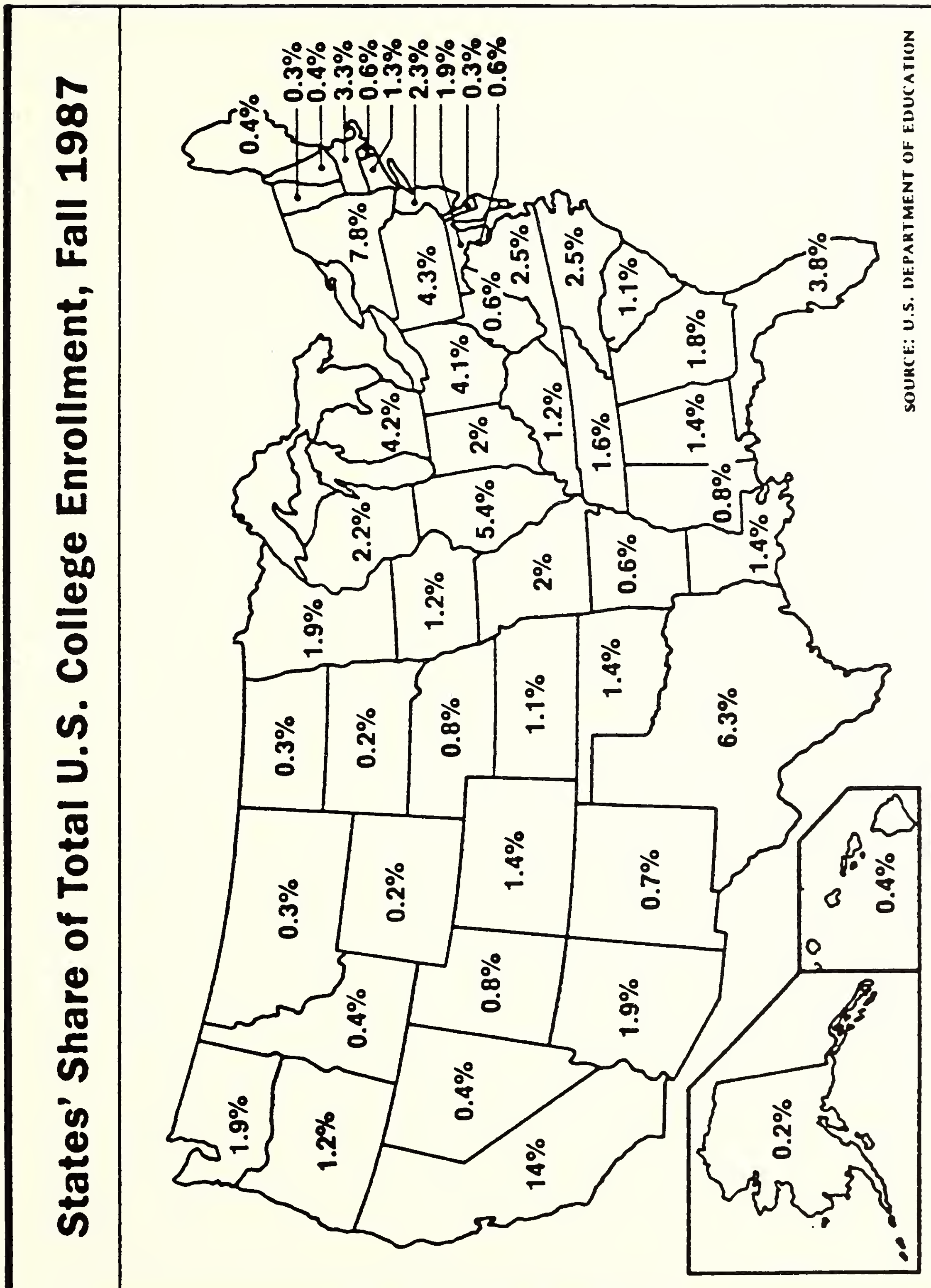

States' Share of Total U.S. College Enrollment, Fall 1987
1.9%
1.2%
14%
0.4%
0.4%
0.3%
0.2%
0.8%
1.9%
1.4%
0.7%
0.3%
0.2%
0.8%
1.1%
1.4%
6.3%
1.9%
1.2%
2%
0.6%
1.4%
2.2%
5.4%
0.8%
4.2%
2%
1.2%
1.6%
1.4%
1.8%
4.1%
0.6%
2.5%
2.5%
1.1%
3.8%
4.3%
7.8%
0.4%
0.3%
0.4%
3.3%
0.6%
0.6%
1.3%
2.3%
1.9%
0.3%
0.6%
0.2%
0.4%
SOURCE: U.S. DEPARTMENT OF EDUCATION

Figure 10

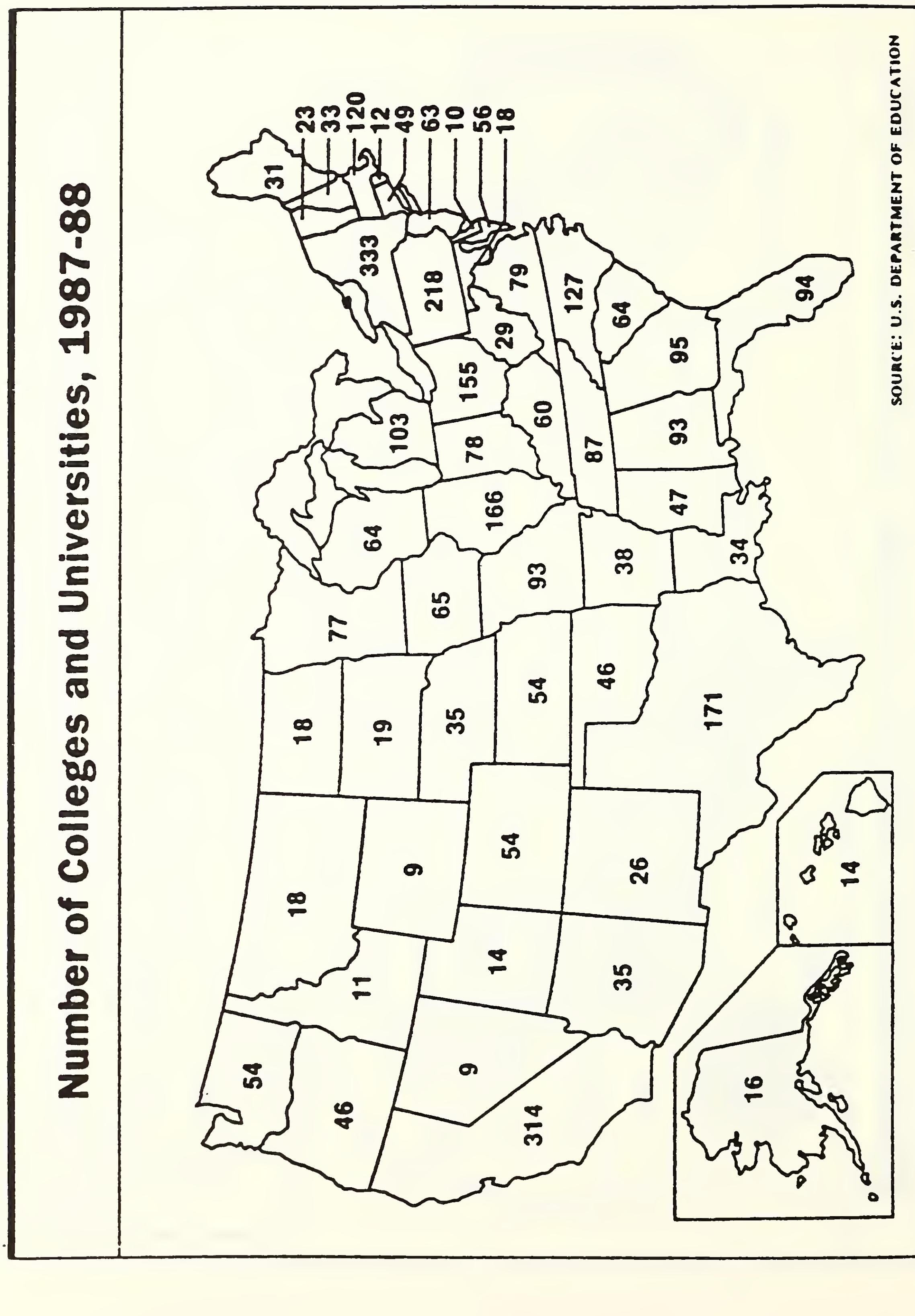

Number of Colleges and Universities, 1987-88
SOURCE: U.S. DEPARTMENT OF EDUCATION

Figure 11

trend by states in raising science and mathematics requirements for graduation from high school has created severe problems for both teachers and students. "In some cases the two- or three-course science requirement is sparking creative responses, as schools add new courses and use old courses in other areas as substitutes. The latter include vocational-technical courses and health or nutrition courses. In other instances, when faced with taking biology, chemistry, and physics, many students simply drop out, further increasing our tragically high national dropout rate of almost 30 percent."

Hans Andersen, President of the National Science Teachers Association at a meeting on October 31, 1989, quoted a U.S. Department of Labor report which stated that 80% of the scientists and engineers in 1989 are white males; but, it is predicted that merely 15% of the individuals entering science and technology professions between 1985 and 2000 will be white males. All reports seem to indicate that in the year 2000 women and minority individuals will be the source of new scientists. Figure 12 provides data concerning the relative numbers of men and women graduating with degrees in the sciences. The increasing difference between the sexes in attaining more advanced degrees is obvious. Furthermore, the differences between numbers of degrees earned in the life sciences and the physical sciences denote the preference of females for the life sciences.

The OTA continued the analysis by observing that expectations among high school sophomores is always higher than reality. ". . . as high school sophomores entering the pipeline in 1980, nearly one-quarter of students were interested in natural science and engineering majors. As seniors, almost as many were still interested in these majors although their field preferences had shifted somewhat. Two years later, 15 percent of the original group of students were in college and planning science or engineering majors. . . . Only 20 percent of this 15 percent indicated science and engineering majors at all three time points in this survey. . . . In all field categories except engineering, more students moved in than persisted."

The OTA continued, "These are some current trends: A continued drop in the number of minority high school graduates who enter college . . . . A continuing increase in the size of the Black middle class, whose children enroll in higher education at about the same rate as do the children of White middle-class families. Continuing high dropout rates for Hispanics. . . . The participation of females, Blacks, and Hispanics in science and engineering has increased substantially during the last 30 years, but is still small relative to their numbers in the general population." Other sources suggest that the Black population tends to choose the armed forces or sports as the pathway to success and that the increase in minority enrollments in colleges and universities rests primarily with foreign and Hispanic students. Other sources state that the largest increase in individuals entering the science and engineering pipeline is in the number of females.

Tables 2 and 3 compare the data for college enrollment numbers between minority and all students for the years 1976 and 1986. Figure 13 depicts these comparisons. Similarly, Figures 14 and 15 indicate the specifics of the minority group for the same years. An inspection of these bar graphs clearly shows that foreign, Hispanic, and Asian students are mainly responsible for the increase in minority college enrollments. Indiana is one of the states having a low percentage of minority college students in 1986.

Non-traditional students (aged 23 and over, attending full time, or not yet 23, but attending part time) are becoming an increasing factor in college education. Individuals who have dropped out of school before graduation are obtaining a high school equivalency certificate which enables entrance into colleges and universities. The *Bloomington Herald-Times* on November 4, 1989, reported that Indiana University's President

NATIONAL, 1986-1987 EARNED DEGREES

| | BACHELOR'S | MASTER'S | DOCTOR'S | % |
|---|---|---|---|---|
| COMPUTER SCIENCES | 39,664 | 8,491 | 374 | ( 1.1) |
| ENGINEERING, TECHNOLOGIES | 93,074 | 22,693 | 3,820 | (11.2) |
| LIFE SCIENCES | 38,114 | 4,954 | 3,423 | (10.0) |
| MATHEMATICS | 16,489 | 3,321 | 725 | ( 2.1) |
| PHYSICAL SCIENCE | 19,974 | 5,652 | 3,672 | (10.7) |
| TOTAL | 991,339 | 289,557 | 34,120 | (100.0) |

Figure 12

Table 2. Minority College Enrollments—1976 and 1986

| | 1976 | 1986 | % increase 1976-1986 |
|---|---|---|---|
| American Indian | 76,000 | 90,000 | 18.4% |
| Asian | 198,000 | 448,000 | 126.3% |
| Black | 1,033,000 | 1,081,000 | s4.6% |
| Hispanic | 384,000 | 624,000 | 62.5% |
| Foreign | 219,000 | 344,000 | 57.1% |
| Minority | 1,910,000 | 2,587,000 | 35.4% |

Table 3. Total College Enrollments—1976 and 1986

| | 1976 | 1986 | % increase 1976-1986 |
|---|---|---|---|
| Minority | 1,910,000 | 2,587,000 | 35.4% |
| White | 9,076,000 | 9,914,000 | 9.2% |
| Total | 10,986,000 | 12,501,000 | 13.8% |

Source: U.S. Department of Education

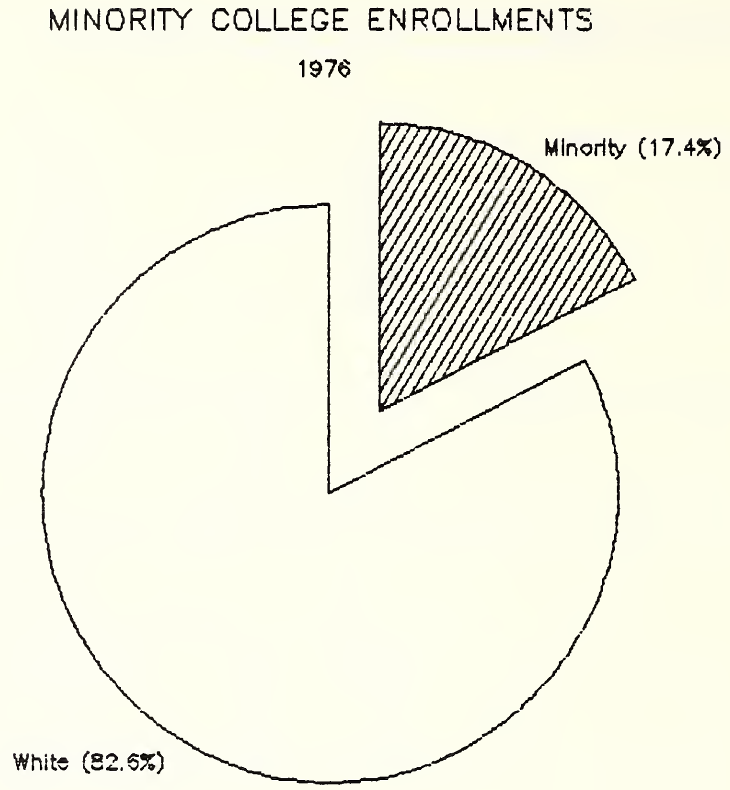
Thomas Ehrlich identified these students as the "New Majority." President Ehrlich noted that females accounted for most of the growth in this kind of enrollment and said, "They are consumers who demand quality teaching."

Data on the percentage of high school graduates provide information that more high school students took science courses in 1987 than in 1982. Further, the percentage who enrolled in biology courses far exceeded the percentage in chemistry or physics. (See Figure 16.) Although included in the data for high school graduates, it is noteworthy that the percentage of minority (Black, Hispanic, and Asian) students enrolled in biology, chemistry, and physics increased in a similar manner from 1982 to 1987. (See Table 4.)

A review of the Indiana Statewide Testing for Educational Progress (ISTEP) program quotes Superintendent of Public Instruction H. Dean Evans in part, ". . . while American students may have knowledge of science facts, they lack the problem-solving skills and strategies to use them productively. These results emphasize the often-heard call for more hands-on/minds-on learning experiences that focus on the applications of science to personal needs and social issues."

The report also asserts, "The results of the science question asked on ISTEP indicated that, generally speaking, only slightly more than half of the students at any grade level demonstrate proficiency in the higher order skills, such as interpreting data to make predictions and draw conclusions; analyzing systems for cause and effect relationships; and applying scientific principles and theories and laws to personal needs and social issues."

The State of Indiana has published "Indiana's Science Education Challenge for the Twenty-first Century." This document delineates the Indiana goals for students. On October 31, 1989, the Department of Education organized a committee to begin a review


MINORITY COLLEGE ENROLLMENTS
1976
Minority (17.4%)
White (82.6%)

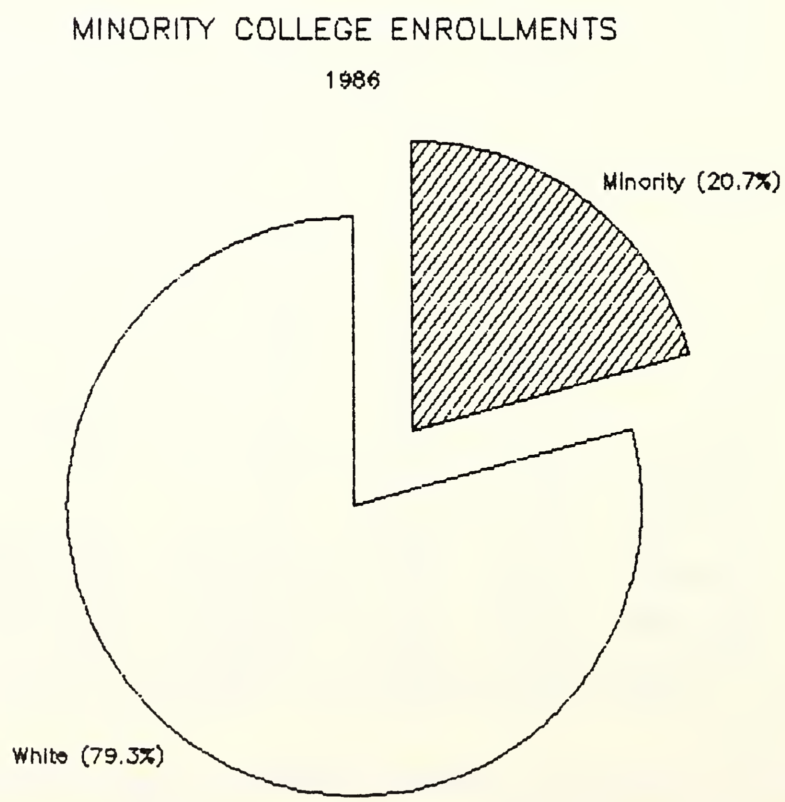

MINORITY COLLEGE ENROLLMENTS
1986
Minority (20.7%)
White (79.3%)

**Figure 13**

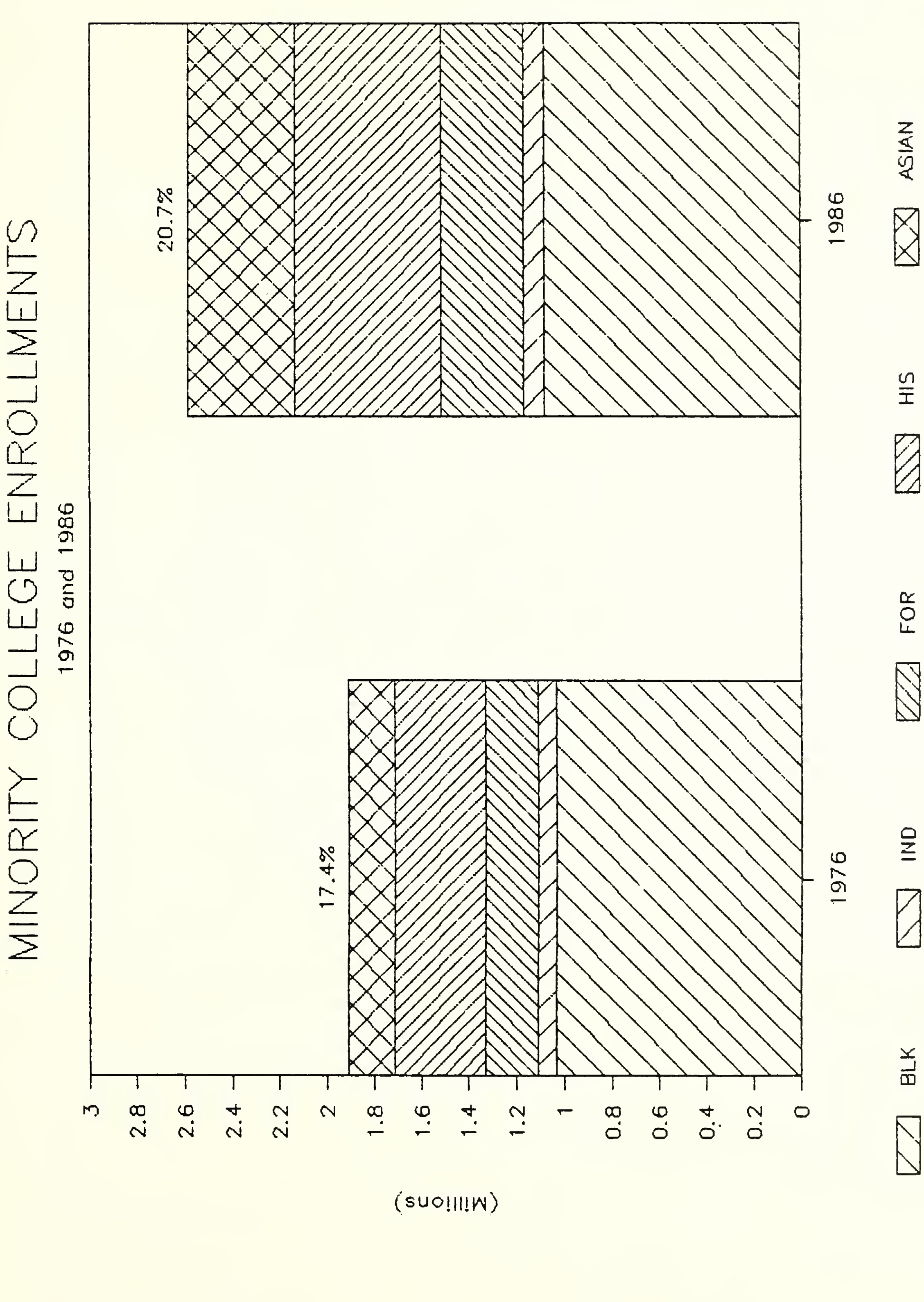

MINORITY COLLEGE ENROLLMENTS
1976 and 1986
(Millions)
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
17.4%
20.7%
1976
1986
BLK
IND
FOR
HIS
ASIAN

**Figure 14**

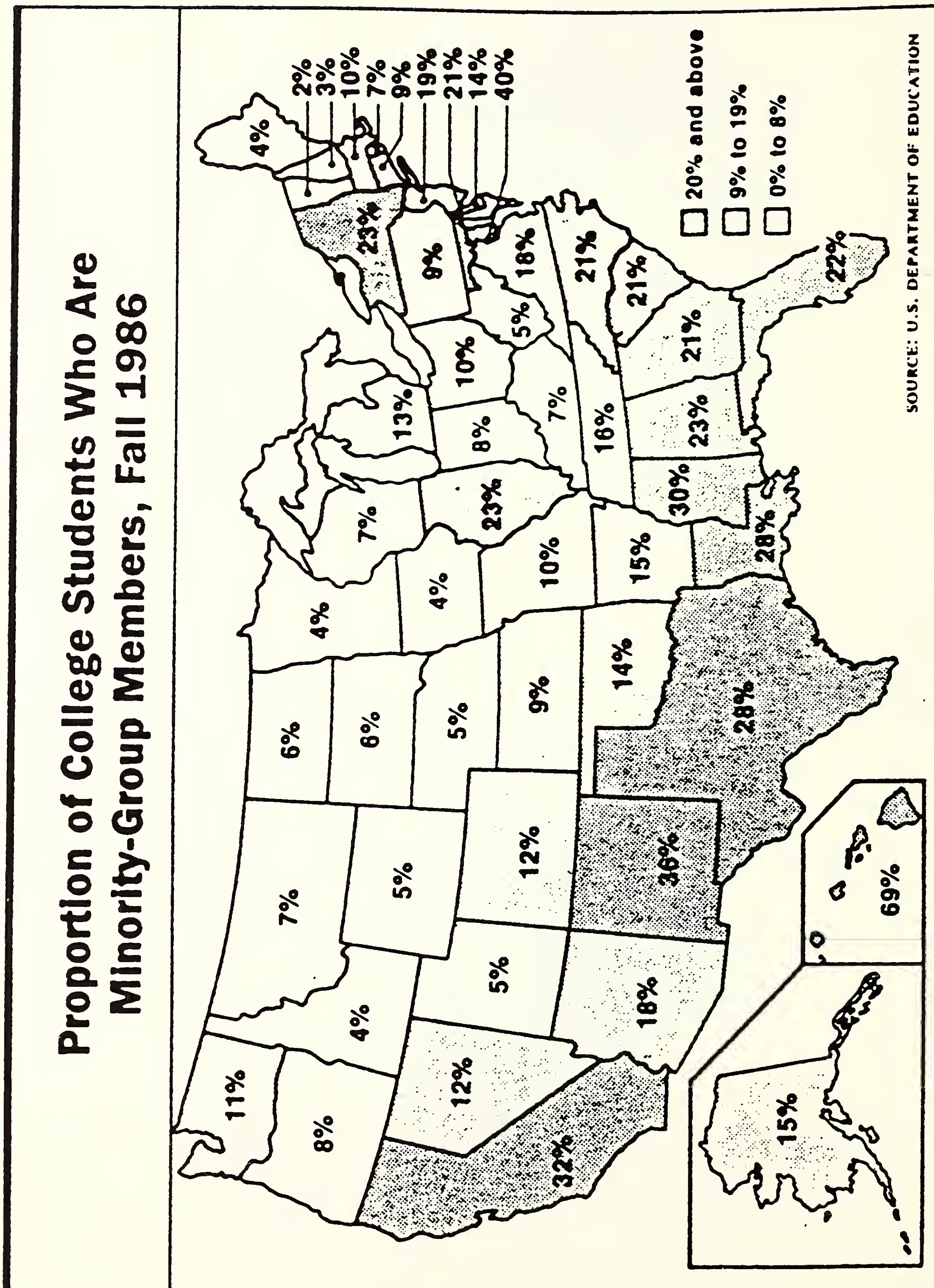

Proportion of College Students Who Are
Minority-Group Members, Fall 1986
20% and above
9% to 19%
0% to 8%
SOURCE: U.S. DEPARTMENT OF EDUCATION

Figure 15

Table 4. Percentage of High School Graduates Who Took Selected Science Courses, by Race/Ethnicity, 1982 and 1987

| | White | Black | Hispanic | Asian |
|---|---|---|---|---|
| 1982 Graduates | | | | |
| Biology | 77.3 | 70.9 | 67.2 | 82.2 |
| Chemistry | 34.2 | 20.5 | 15.4 | 51.4 |
| Physics | 16.0 | 6.9 | 5.6 | 33.8 |
| 1987 Graduates | | | | |
| Biology | 91.0 | 84.7 | 85.9 | 93.3 |
| Chemistry | 48.0 | 30.3 | 31.8 | 72.3 |
| Physics | 21.1 | 10.6 | 11.2 | 50.0 |

Source: *NSTA Reports!*. National Science Teachers Association, September/October 1989.

and, if needed, a revision of the state science proficiencies. Several members of the Indiana Academy of Science are serving on this committee.

## *SCIENCE CURRICULUM* — WHAT ARE THE TRENDS?

When I began teaching, I was told that total science knowledge was doubling every nine years; a few years later this was changed to every seven years. I can not attest to the accuracy of this claim (it seemed to be common knowledge) but I feel sure that the rate at which total science knowledge increases has greatly accelerated with the advent of computer management of data. Often, teachers are expected to teach more and more — to incorporate additional topics (such as AIDS, nutrition, drug abuse) into the instructional day with no attempt to identify topics that can be omitted from the curriculum.

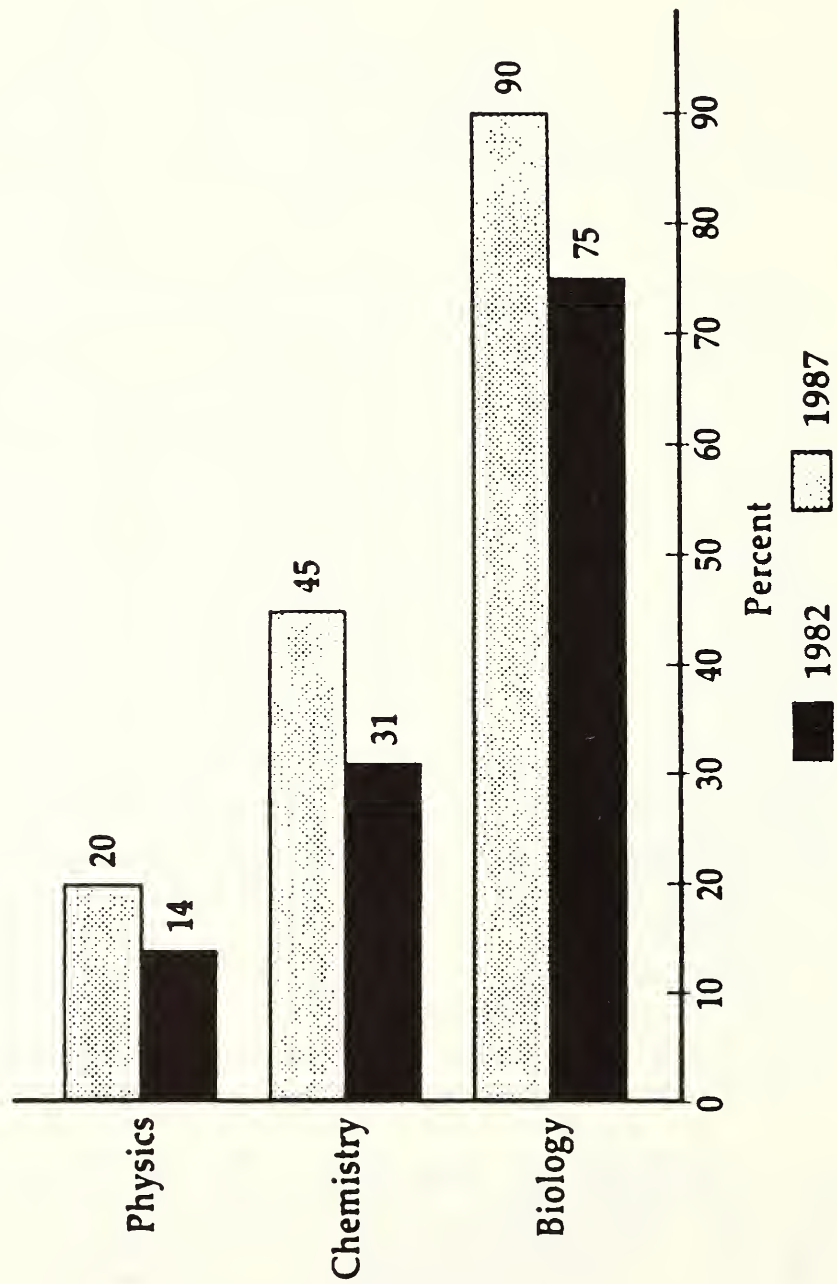
The Office of Technology Assessment stated, "It is widely believed by college educators that the quality of high school students who are planning science and engineering majors may be declining compared to their predecessors. While this belief has probably been held by all teachers who try to transmit knowledge to their juniors, there is little evidence to support it."

Hans Andersen reported that the Governors' conference on education has mandated that a list of proficiencies be prepared and published by early 1990 — perhaps as early as January. In essence, this will be a national curriculum. It might have an important impact since politicians control the purse strings, and money determines what happens when.

The American Association for the Advancement of Science (AAAS) started a curriculum revision effort in 1986 — the year that Halley's Comet arrived. The title of this project is "Project 2061: Science for All Americans." (It is named for the year of the next advent of Halley's Comet — in recognition of the need to change the thinking of science teachers and the public and in realization that change occurs slowly.)

The first three years of Project 2061 has been spent in defining the accepted national goal of scientific literacy for all. The Project started by defining ". . . a conceptual base for reform by spelling out the knowledge, skills, and attitudes all students should acquire as a consequence of their total school experience from kindergarten through high school. . . . A fundamental premise of Project 2061 is that the schools do not need to be asked to teach more and more, but to teach less so that it can be taught better."

**Percentage of High School Graduates Who Enrolled in Science Courses**




Source: Educational Testing Service, Policy Information Center, "What Americans Study." Available from ETS Policy Center, Educational Testing Service, Princeton, NJ 08541-9452.

Figure 16

One difference in the curriculum, according to AAAS is ". . . that boundaries between traditional subject matter categories are softened and connections are emphasized. Transformations of energy, for example, occur in physical, biological, and technological systems, and evolutionary change appears in stars, organisms, and societies."

This report continued, "A second difference is that the amount of detail that students are expected to retain is considerably less than in traditional science, mathematics, and technology courses. Ideas and thinking skills are emphasized at the expense of specialized vocabulary and memorized procedures."

"The subject matter investigated and techniques used within the various sciences change with the time and the development of new instruments, and the boundaries of scientific disciplines are constantly shifting. Even so, the general attributes of scientific inquiry persist. Descriptive, experimental, and historical approaches are used, depending on the phenomena being studied and the tools at hand. However, the approaches are all alike in their demand for evidence, their use of testable hypotheses and logical reasoning, their search for explanatory and productive theories, and their efforts to identify and avoid unscientific guessing."

The AAAS *Science for All Americans* curriculum project, ". . . does not advocate, however, that all students need to gain detailed knowledge of the scientific disciplines . . . the report recommends that students develop a set of cogent views of the world. . . ."

"To ensure the scientific literacy of all students, the curricula must be changed to reduce the sheer amount of material covered; to weaken or eliminate rigid disciplinary boundaries; to pay more attention to the connections among science, mathematics, and technology; to present the scientific endeavor as a social enterprise that influences — and is influenced by — human thought and action; and to foster scientific ways of thinking," continued the report by AAAS.

"This includes starting with questions about phenomena rather than with answers to be learned; engaging students actively in the use of hypotheses; the collection and use of evidence, and the design of investigations and processes; providing students with hands-on experience with mechanical, electronic, and optical tools; placing a premium on students' curiosity and creativity; and frequently using a student team approach to learning."

Will this curriculum really provide opportunities for *The Forgotten Half: Non-College Youth in America*?

Aldridge noted a suggestion that the National Science Foundation (NSF) support an educational model that will bring a larger population into science careers, thus "broadening the pool" rather than "skimming the cream."

Aldridge stated, "Recent NSF studies, as well as most other major reports, urge us to focus on science education for the general public." Later in the report he noted that in elementary schools children study science mainly by reading about it, in junior high schools children study earth/space science, physical science, and biology; and in secondary schools, children study one or all of biology, chemistry, and physics; astronomy, geology, earth science, and advanced science courses are not studied.

Aldrich states that the NSTA is proposing a six year revised curriculum for grades 7 through 12. The revision would incorporate increased time spent on instruction and study of the four areas of science (biology, chemistry, physics, and earth/space science) in progressive steps depending on the course content — for example, grade 10, descriptive, phenomenological; grade 11, empirical, semi-abstract; and grade 12, theoretical, abstract.

Will this curriculum be suited to *The Forgotten Half: Non-College Youth in America*?

*Teachers* — What must be done?

Regardless of curriculum innovations, teachers are the heart and soul of the educational process. Teachers often are accused of all sorts of faults without receiving any recognition for all the good teaching which is done.

Something forgotten by most critics of pre-college education is that all children, regardless of desire for learning or intellectual ability, are taught by dedicated teachers. Many of these dedicated teachers teach "The Forgotten Half." Who are "The Forgotten Half"? These are the high school drop-outs and the high school graduates who do not attend college.

Does the Indiana Academy of Science have any responsibility to provide encouragement rather than doubt and distrust? How can the Academy discourage "Teacher Bashing?" Does the Indiana Academy of Science have any responsibility to provide support and cooperation? How can the Academy help science teachers to an even greater degree than in the past?

In summary, the members of the Academy have completed many "Labors of Hercules" while working to improve and yet have displayed the "Patience of Penelope" when changes occur slowly. I encourage the members of the Academy to display these same characteristics as the problems of science teachers are considered.

I wish to thank all of the members of the Academy, the committees, and the chairs of the various sections for their participation in the Academy programs. In addition, I thank you for listening to my plea for improving science education for all people. Again, I ask the Indiana Academy of Science, "Quo vadis?"

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