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TRENDS AND INITIATIVES IN SCIENCE EDUCATION IN INDIANA, 1988

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ABSTRACT: The general state of science education in Indiana is profiled, including state rank by students enrolled, adult academic attainment by high school and college graduation rates, average student SAT scores, gross-state-product-per-school-age child, spending-per-pupil-in-attendance, and actual per-pupil spending at elementary, secondary, and college levels. Teaching conditions included school staffing and teachers salaries, and graduations from Indiana high schools are estimated. Trends detected by a limited survey of Indiana science teachers include a major abandonment of blood typing labs (primarily due to the "perceived danger of AIDS"), increased use of computers, substantial cutbacks in field trips (due to red tape, costs, and state "time-on-task" regulations), a substantial reduction in advanced science courses in order to meet the two-sciences-to-graduate regulation, indications that uncertified science teachers substantially exceed previous state estimates, continued use of laboratory work but substantial time instructing students in lab safety, increased use of VCR's but inadequate units to replace film projectors, serious gaps in some teachers' knowledge of off-air taping and copyright regulations, and continued use of dissection but substantial decrease in the practice due mainly to cost but also animal rights and public relations concerns. Evolution/creationism was considered to no longer be a classroom issue by two-thirds of the respondents but a disturbingly high one-in-five teachers favored "equal time" for creationism in science classes. Biology teacher production queried from Indiana colleges and universities appears to remain about one-fourth the 1968 levels.

INTRODUCTION

Comparisons of student math and science performance on international assessments (Lapointe, *et al.*, 1989), audits of students in the United States' science-and-engineering pipeline, and the rise in incidents of silly verdicts and other consequences of science illiteracy in the public at large (Bien, 1988; Hively, 1988; Lewenstein, 1988) provide solid and incontrovertible evidence that the understanding and valuing of science in the United States is lower than in other developed countries and is inadequate to meet both national social and economic needs as well as personal intellectual growth.

Virtually no hint of this deterioration can be found in the pages of science education journals during the last ten years. Instead, these journals provide a steady stream of educational innovations. Nevertheless, there are objective indicators embedded in government reports and surveys not often seen by the science community. Following a model established by R.W. Meyer (1987) in reporting state entomological conditions, this report compiles available statistics to describe to Indiana scientists the educational situation in Indiana science classrooms. In addition to compiling data from a wide range of state and national sources, a limited survey was conducted of junior and senior high school science teachers in the fall of 1989. The survey was sent to less than 500 but more than 100 teachers (number concealed to assure anonymity) with a return rate of 37 percent. The survey covered all regions of Indiana, rural and urban, and all science disciplines (Table 1).

Table 1. Responses to a limited survey of Indiana science teachers, 1989.

Blood typing	
Not a biology teacher	34%
...Of the 66% who were biology teachers	
I have never conducted blood-typing labs with students	17%
I still conduct blood typing labs	22%
I formerly conducted blood-typing labs have now stopped	52%
...Of those who stopped	
Due to perceived danger of AIDS transmission	67%
My professional decision unrelated to outside public issues	25%
Change in curriculum unrelated to outside public issues	16%
"Orders from above" (principal, new school policy, etc.)	8%
Cost of blood-typing reagents and equipment	8%
Computers	
My school doesn't provide computers for teacher or student use	6%
I have access to a computer for test writing, grade keeping, etc	74%
One or more computers are available to my science students	77%
...Usage where students have computer access	
Simulations	40%
Word-processing for report writing	40%
Data management	34%
Individual remediation	31%
Interface with real experiments to analyze real data	29%
Independent advanced projects for students	26%
Drill and practice in day-to-day lessons	17%
On-line access to outside resources	9%
...I perceive computer use as replacing	
Lecture time	17%
Lab time	31%
Other	46%
...Money for computer hardware and software was	
External to the science budget	69%
Subtracted from science lab equipment and supplies	11%
Other	9%

...I perceive computer use in science class as

A major improvement over my previous lecture,discussion, lab	20%
Just another tool similar to the typewriter, calculator, etc	43%
A serious threat to real labs, field trips, etc	6%
Other	17%

Field trips

I have never taken nor need to take field trips outside the school grounds and beyond one class period	3%
I continue to use all the field trips I need	48%
My use of field trips has been substantially reduced	57%

...Among reduced, because

Due to administrative "red tape," insurance, forms, etc	51%
Financial cost of field trips became too high	45%
State restrictions under "time-on-task" regulations	45%
In my opinion, they were not as valuable as other classwork	15%
Use of VCR or other audio-visuals replaced the need for fieldtrips..	5%

Methodology: I make use of (check all that apply)

Laboratory work	92%
Problem-solving techniques, open questions,etc	88%
Science career information	46%
Dissection	23%
Madeline-Hunter-style class lesson plans	28%
Individualized computer-assisted instruction	29%
Science/Technology/Society issues	26%
Field trips	26%
Effective schools research	17%
Outside speakers from industry, academia, etc	17%
Co-operative teaching or peer teaching	14%
Writing across the curriculum	14%
Instruction via satellite TV (Star Schools)	0%
Other	17%

Handle new two-science-to-graduate requirement

Never dropped to one-science-to graduate; did not need to add a course	9%
Increased class size in introductory science courses	34%
Added enough qualified faculty to cover the additional courses	31%
Canceled advanced sciences to staff more introductory classes	11%
Struggling to schedule students into their second science course	3%
Other	20%

Laboratory safety

I do not conduct labs	0%
I spend substantial time instructing students in lab safety	86%
I require students to sign a statement that they have read and understand the lab safety procedures in my class	43%
Safety rests solely in my professional planning and care	34%
I have purchased liability insurance to cover myself	9%
Other	8%

Videotapes and broadcast programs

My school does not have videocassette players	0%
My school has too few VCR's (overbooked, disrepair)	29%
I feel I can legally record TV science programs at home and view them myself at a later date	49%
I off-air TV science programs and use them in appropriate classes through the school year	52%
I use small portions of broadcast TV programs in class under "fair use"	46%
I make heavy use of school/consortium-purchased commercial videotapes	17%
My school prohibits me from using in class videotapes I record at home	8%
Other	9%

Dissection (Biology only)

I have never used dissection regulary in coursework	4%
I continue to use dissection	52%
I have decreased or halted the use of dissection	40%

...Reason for decreased dissection

Cost considerations	67%
Animal rights efforts or other public relations concerns	45%
"Orders from above"	11%
Replacement with computer simulations	11%
Replacement with models	0%

Evolution/creationism

I believe creationism should have "equal time" in science classes	20%
My textbook does **not** provide adequate coverage of **evolution**	14%
My textbook does **not** provide adequate coverage of **creationism**	20%
I do not feel I have an adequate content background to prepare me to teach about evolution	6%

I am not permitted to cover the topic of evolution in science class...	0%
It would be unwise for me to discuss evolution in science class.....	5%
This is no longer an issue; I can cover evolution as I judge fit.....	65%

Future: In the next five years (mark all that apply)

I plan to take more science coursework (biology, chemistry, etc.)....	40%
I plan to take more education methods coursework.....	17%
I except to leave public school teaching or retire.....	11%
I anticipate school situations and the teaching profession will improve.....	43%
I anticipate school situations and the teaching profession will get worse.....	23%
I anticipate school situations and the teaching profession will stay the same.....	29%

*Total percentages may not add up to 100 percent, since more than one answer can be marked or all selections may be left blank.

STATE AND NATIONAL EDUCATION STATISTICS

In size, Indiana ranks thirteenth in numbers of both elementary/secondary and higher education students and has held this ranking during the gradual decrease in school-age population over the last decade.

In academic attainment, according to the last census, one-third of Indiana adults have not completed high school (rank 34) and only thirteen percent have four or more years of college (rank 42). Average student SAT scores have consistently remained near the bottom of 50 states, ranking 46th in verbal and 47th in math (College Board, 1989). While it is true that states with higher percentages of high school graduates taking the SAT "dilute down" their average scores, 16 other states exceeded Indiana's 55 percent proportion of high school graduates taking the SAT.

In resources available, Indiana ranks 35 in gross-state-product-per-school-age-child. While spending-per-pupil-in-attendance has grown from $2,144 in 1970 to $3,761 in 1987, this level has dropped from 11 percent to 14 percent below the national average, and Indiana ranks 34th in per-pupil spending. Of $748 spent per citizen in Indiana on education, $492.50 goes to elementary and secondary schooling, and $216.43 goes to higher education.

There are important differences between the U.S. Department of Education-calculated figures (Barbett, *et al.*, 1988) of school staffing and National Education Association figures (1987) which appear to be based on public schools only. A U.S. Department of Education survey reveals that Indiana uses more support staff (counselors, librarians, aides) and relatively fewer administrators and teachers than the U.S. average. The Indiana teacher:pupil ratio of 19:1 is approaching the U.S. average of 18:1. A small "boomlet" that is currently progressing through elementary schools will cause a temporary recovery in the steady decline in Indiana high school graduates before the end of the century. The Western Interstate Commission for Higher Education projects high school graduates for Indiana will number: 67,281 in 1989-90; 59,753 for 1993-94;

64,444 for 1997-98; 58,205 for 2001-02; and 57,757 for 2003-04. Another national estimate predicts a 12 percent drop in number of Indiana high school graduates between 1988-89 and 1998-99 (United States Department of Commerce Bureau of the Census, 1988).

After lagging behind inflation, the national average teacher salary finally caught up to and passed the previous 1971 high point in purchasing power (National Education Association, 1988; Olson, 1989b). Nationwide, teachers average about $500 per year more in purchasing power. However, Indiana teachers lag behind the national average by about $1,500, and the state ranks 26th in average teacher salaries. One estimate of 1986 average Indiana teacher salaries found an increase of only 0.3 percent from the 1969-70 salaries, when adjusted for inflation. And "average" salaries do not reflect the high variation in beginning teacher salaries, high teacher attrition rates, and reluctance to hire experienced but costly veteran teachers.

Graduations from Indiana high schools are estimated at 64,000 for 1988, a decrease of 15.9 percent from the 1980-81 school year. In spite of decreased high school enrollments over the last decade, colleges and universities overall have sustained a 1.2 percent enrollment growth since 1980 through a higher percent of high school graduates entering college and the return of older or "non-traditional" students. Of 256,264 post-secondary Indiana students, 215,091 were undergraduates, 5,489 were in professional schools, and 29,598 were in graduate programs in 1988. Full-time-equivalent college enrollment per 1000 capita is 47.7, which ranks Indiana 31st. Total U.S. college enrollment in biological sciences is 47,878 for 1985, down 3.4 percent from 1977. In 1988, Indiana college degrees of four years or more in life sciences comprised 3.3 percent of degrees, which is 30 percent below the national average. Physical science college degrees in Indiana were 2.6 percent of total degrees, which is 18 percent above national average (Table 2; Barbett, *et al.*, 1988; National Center for Education Statistics, 1989).

BLOOD TYPING

It is impossible to move among public school biology teachers without being aware of the massive retreat in the last few years from real blood-typing lab experiences that have always yielded high student interest. Of the Indiana biology teachers surveyed, 22 percent still conducted such labs, and another 17 percent never did. Of the majority who have stopped using the exercise, two-thirds indicated it was due to the "perceived danger of AIDS transmission." While in some regions AIDS has served as a rationale for interjecting much-needed sexuality education into the curriculum, it appears that blood-typing labs have become a widespread "innocent victim." In summarizing the occurrence of contagious diseases for the United States, the Center for Disease Control (1987) ranks AIDS 10th behind a formidable array of other diseases at 3.46 cases per 100,000 in the general public at large. With school children at far less risk for needle-abuse and high-risk sexual practices, the dangers from various forms of hepatitis by blood contamination remain far greater threats than AIDS. With the wide array of Pen-Let, Auto-Let, and other blood self-sampling devices available with disposable lanclets, changeable platforms, and sharps disposal containers, biology class blood-typing labs remain easy-to-conduct, economical, and safe. Included in volunteered comments were "possible legal problems by lawsuit-happy public." While a few respondents noted that the "school doesn't allow it" or marked "orders from above," the main constraints on blood-typing labs appear to be self-imposed.

Table 2. Educational statistics (Council of Chief State School Officers, 1988; see text for additional citations). Unless otherwise specified, all the data reflect figures for Indiana.

Indiana Demography	Amount or %	State Rank
Number of school districts	305	20th
School-age population K-12, 1976	1,293,000	13th
School-age population K-12 1986	1,084,000	13th
Public elementary school enrollment (K-8), 1986	653,613	----
Public secondary school enrollment (9-12), 1986	313,167	----
Total instructional staff, 1987	58,906	----
Total elementary teachers, 1986	24,246	----
Total secondary teachers, 1986	23,554	----
Post-secondary students, 1989	256,264	13th
Percent of adults with 4 years high school, 1980	66.4%	34th
Proportion of adults with 4 years college, 1988	13%	42nd
Gross-state-product-per-school-age-child, 1986	$71,231	35th
Percent high school dropouts, 1986	23%	16th
Percent high school dropouts US, 1986	29%	----
Spending per-pupil-in-attendance,1970	$2,144	----
Spending per-pupil-in-attendance US, 1970	$2,403	----
Spending per-pupil-in-attendance, 1986	$3,275	----
Spending per-pupil-in-attendance, 1987	$3,556	----
Spending per-pupil-in-attendance US, 1987	$3,977	----
Spending per-pupil-in-attendance, 1988	$3,761	----
Spending per-pupil-in-attendance US, 1988	$4,386	----
Teacher Salaries		
1985 average teacher salary	$22,854	21st

1986 average teacher salary	$24,248	24th
1986 average teacher salary, US	$25,240	----
1987 average teacher salary	$25,191	26th
1987 average teacher salary, US	$26,698	----
1988 beginning teacher salary, US	$18,557	----
1988 average teacher salary, US	$28,085	----
1989 average teacher salary, US	$29,567	----

SAT scores	Indiana	US	Rank
Average combined, 1978	870	897	----
Average combined, 1983	864	893	----
Average combined, 1987	874	906	----
Average combined, 1988	870	904	----
Average combined, 1989	871	903	----
Average verbal, 1989	412	427	46th
Average math, 1989	459	476	47th

COMPUTERS

Computers were available at nearly all the respondents' schools for some student or faculty use. About three-fourths of the teachers made use of them for test writing or grade keeping. Student usage was low for drill-and-practice in day-to-day lessons and higher for simulations, report-writing, data management, remediation, and interfacing with real experiments. A more perceptive survey instrument is needed for determining the extent to which these uses occupy the students' classroom time.

An attempt to pinpoint whether computer time detracts from lecture or lab time was not successful. If all class activity is generalized into either lecture/discussion or lab activities, any in-class computer activity would take away from one or the other. However, nearly half of the respondents perceived computer use as coming from some other activity allotment. Since there is no indication that extra class time was made available (indeed, many Indiana schools have shortened class period length), future surveys will have to more accurately define when computer use is occurring.

Most respondents indicated the cost of computers was not subtracted from science budgets. Some bought computers on grant money or by science club fund-raising. Many noted that hardware was externally funded, but software was bought within the science budgets as a classroom supply. It was commonly volunteered that one computer for a class of students was restrictive and a lack of multiple copies of software was a "frustrating issue." Computer rooms were often overbooked. Several respondents indicated that very little software is valuable enough or designed well enough to deserve class time. Most consider the computer to be another tool similar to the typewriter and do not see it as a threat to real science experiences.

FIELD TRIPS

Field trips are conducted by nearly all science teachers. However, over half of the respondents have "substantially reduced" the number of field trips and do not take all the

field trips they judge they need. The three main reasons underlying this cutback were: 1) administrative red tape, insurance, and forms; 2) the financial cost of field trips; and 3) state "time-on-task" regulations. Several noted that the availability of new nature centers on school grounds fulfills some field experience needs and relieves some liability and time-on-task concerns.

Worry over liability underlies much of administrators' concern, according to a recent national NASSP survey of principals (Rothman, 1989). Although few schools have been involved in lawsuits, many officials have "...acted to reduce their risks out of fear of potential losses." Across the nation, class field trips ranked third (behind gymnastics and diving/scuba) as activities terminated due to liability concerns. Field trips rated second (behind PE/gym) among in-school programs "modified." Among 190 principals, there were 14 cases of lawsuits involving field trips, three instances of high premiums, and three cases where no insurance was available for field trips, all during the last two years. In this state survey, a common attitude may be summarized by one teacher's write-in comment on field trips: "administration frowns on them—hassle." It is apparent that preservice teachers will have to have a solid understanding of the irreplaceable educational benefits of fieldwork, if such studies are to remain part of public school science teaching.

When time-on-task regulations were promulgated in Indiana, attendance at IAS Junior Academy of Science meetings plummeted, and some school teachers reported attending Academy meetings on personal time at their own expense. While this is supposedly not the intent of these regulations, and teacher and student attendance at Junior Academy of Science meetings has rebounded, it is obvious that a substantial number of Indiana school administrators are still using time-on-task to curtail science field trips.

METHODOLOGY

Indiana science teachers remain committed to laboratory work and feel they use problem-solving techniques and open questions. About half cover science career information, commonly inserted as blocks in current textbooks. Over one-fourth incorporate science/technology/society (STS) issues, also often "blocked" in textbooks. While 97 percent took field trips at some time, only one-fourth are making "increased use of" field trips. Educationist innovations such as Madeline-Hunter-style lesson plans (mandated in Texas and elsewhere), effective schools research, co-op and peer teaching, and writing-across-the-curriculum are not common in Indiana science classrooms.

NEW GRADUATION REQUIREMENTS

Many states, including Indiana, required only one year of high school science to graduate in the 1970's. Indiana joined in the movement to increase requirements for graduation (19.5 Carnegie units overall to include 2 years of science). In 1988, three states required three years of science, 30 required two years, and 18 still required less than two (count includes the District of Columbia). Not all Indiana schools had dropped to requiring only one-science-to-graduate (estimated at near 10 percent in this survey). However, according to Colglazier (personal communication), nearly 40 percent of

Indiana students graduated with only one science during the 1970's. Indiana schools are consolidated and do not have a large number of small schools with small science class enrollments that could absorb a doubling of students.

It is presumed that the original intent of the increase to two-sciences-to-graduate was to increase students' minimum science exposure without canceling advanced science classes or shortening or overcrowding introductory science classes. If these quality factors are held, then this mandate would require that new science faculty be hired to provide additional classes to accommodate a number of students roughly equal to 40 percent of the graduating class. Since there has been a sharp reduction in science teacher production at Indiana universities and colleges in the last 20 years, this should have caused a dramatic shortage of certified science teachers. However, a survey by Harty and Kloosterman indicated "no general shortage of certified biology, chemistry, or earth science teachers in high schools" (Colglazier, 1988). This conclusion was accepted by the Indiana State Department of Education despite challenges that the figures were "invalid" (Schrock, 1986).

One recourse for many schools was to reduce "...the school day from one consisting of six fifty-five minute periods to one of seven fifty minute periods...thus reducing the instructional time required for science from 275 to 250 minutes per week...a loss of over seven clock hours (72.9 vs. 80.2 clock hours) of instruction time per credit" (Colglazier, 1988). The movement to a 180-day school year restored two of the lost hours. While this allows schools to stretch a science teacher to cover one more class, depending on the size of the school, it still falls short of delivering the second course for a number equivalent to 40 percent of the high school graduates.

Forty percent of the respondents indicated a legitimate resolution of the dilemma: either they had not dropped to one science to graduate previously, or they had added enough qualified faculty to cover the additional courses. Of the remaining 60 percent, 34 percent resorted to increasing introductory class sizes, over ten percent canceled advanced classes, and others indicated various strategies, ranging from more classes per day to simply giving seniors priority on the second science and temporarily postponing the shortage. The loss of advanced classes is particularly worrisome, since this is often the springboard that launches science-interested students into college, and advanced courses with enthusiastic science students serve as rewards to keep our best science teachers in teaching. Reduction in advance science classes and overcrowded introductory classes are not the intended consequences of the two-sciences-to-graduate regulation.

These problems were also detected by a nationwide survey by the Center for Policy Research in Education (Olson, 1989a), which found that the widespread increase in high school graduation requirements was accompanied by scattered evidence of attempts to "water down" the curriculum. In particular, their survey found cases where low-quality academic classes replaced higher-quality vocational ones. Colglazier (1988) describes the Indiana dilemma for an STS-type Principles of Technology course sequence that gains science credit when taught by physics teachers but not when taught by vocational teachers. Colglazier refers to other states where such STS "sciences" are taught by non-science teachers, exposing another "legitimate" potential method of filling a science teacher shortage with non-science teachers. According to comments on an Indiana survey form in this study, this is already the case in Indiana: "...the 2-year requirement of science has too many loopholes, allowing non-academic classes to count. Many of the courses are a farce—freshman physical science for example..."

While the previous criticism of the Harty and Kloosterman report (Schrock, 1986) was based on observations by a few teachers that uncertified science teachers in their local region exceeded estimates reported for the whole state, the failure of the doubled graduation science requirement to create a science teacher shortage reinforces the assertion that the reported certification levels (98.6 percent in biology; 97.3 percent in chemistry; 96.7 percent in earth sciences; 92.7 percent in general science; and 89.2 percent in physics (Colglazier, 1988)) are seriously inflated by school administrators and useless for decision-making. Strategies for covering up uncertified teachers and science shortages in Kansas include: renaming a course to justify another certification (i.e., physics changed to physical science), listing a certified teacher as overseeing a course actually taught by an uncertified teacher, and declaring no shortage if a course is not offered. To detect which strategies are used in Indiana, and to what extent, would require a more detailed open-ended survey of teachers.

LAB SAFETY

All Indiana teachers reported conducting labs, and most spend substantial time instructing students in lab safety. The practice of requiring students to sign a statement that they have read and understood safety procedures is a new legalism unheard of 20 years ago, yet found in over 40 percent of Indiana science classrooms today. Such forms do not protect teachers who are negligent but may dissuade some parties from considering legal action. One-third of the science teachers firmly assert that safety rests solely in their professional planning and care. Nine percent purchased liability insurance, and another 8 percent indicated they were covered via Indiana State Teachers Association or school-purchased insurance.

Obviously, science teachers are responding to an atmosphere of heightened concern over liability. This was reflected in the NASSP national survey, already mentioned in the field trip discussion, where out of 190 principals, 15 indicated they had modified policies on science labs, including "...eliminating the use of certain chemicals in science laboratories," nine had lawsuits related to science labs, and four attributed high insurance premiums to laboratory work during the last two years (Rothman, 1989).

VIDEOTAPES AND BROADCAST PROGRAMS

All schools are likely to have VCR's, although over one-fourth of the respondents indicated the numbers were inadequate. Some teachers elaborated, explaining how six film projectors were replaced by two VCR's, resulting in overbooking and no flexibility. In addition, VCR repairs apparently take the machine out of commission for longer periods than movie projector repairs. Administrators often bought units with no counter or auto-stop in order to save a few dollars but thereby discarding the major advantage of VCR's in excerpting material.

The survey also indicated serious gaps in some teachers' knowledge of off-air taping and copyright regulations. Only half expressed comfort in privately off-air taping for playback at home, a fully legitimate practice. However, over half felt they could "off-air record TV science programs and use them in appropriate classes through the school year." While a few programs are explicitly produced and promoted for free teacher-videotaping and use in class, most programs such as *NOVA* and *Nature* are distributed commercially. While broadcast programs may be taped and used for ten

class days and evaluated for 45 calendar days, it is likely many teachers trained in the pre-VCR era are not aware of the intricacies of this not-so-new copyright arrangement. At the other extreme, some schools legalistically prohibit teachers from using any home-recorded tapes, needlessly depriving students of much up-to-date high-interest science programming.

DISSECTION

Among Indiana biology teachers, a majority continue to use dissection, although four percent never did. However, 40 percent have decreased or halted dissection use. Among those who cut back or stopped, two-thirds reported cost as the main factor. However, 45 percent cut back due to animal rights and public relations concerns. Comments volunteered in the survey included: "no time to do labs," "in past we dissected 4 organisms...we are discontinuing," "curriculum more cellular oriented," "use live animals for observation." This issue deserves close scrutiny in future surveys, including analysis of the effect of the new National Association of Biology Teachers' policy discouraging dissection.

EVOLUTION AND CREATIONISM

Nearly two-thirds of the respondents consider evolution/creationism to no longer be a classroom issue. However, one in five teachers favored "equal time" for creationism in science classes, and one-in-five (not exactly the same respondents, but much overlap) felt their textbooks did not provide adequate coverage of creationism. While some volunteered "I do NOT teach creationism", 5 percent indicated it would be unwise to discuss evolution in science class and comments included: "school adopted policy statement—'one of many possible theories'," "my fellow biology teachers do not wish to teach a unit on evolution...I manage to work it into genetics, anatomy, ecology."

While the interest in creationism among this sample of Indiana science teachers is low, comparable levels for flat earth theory in earth science or astrology in astronomy would be alarming. A more extensive survey is needed in the future to probe the extent creationism is purveyed in earth science, astronomy, and biology classes.

FUTURE

The final survey question indicated that many teachers plan to take additional coursework and that they feel they need more science content coursework as compared to education methodology.

In some states, 40 percent of the certified teachers no longer teach in public schools. Nationwide, five out of ten teachers leave teaching within the first five years, and seven out of ten within the first ten years. The 11 percent planning to leave or retire within the next five years indicates that this sample of Indiana science teachers is comparatively stable. When the *Indianapolis Star* surveyed residents early this year, they found 41.6 percent felt educational quality had remained level, while 19.8 percent said it had deteriorated. This survey found 23 percent of science teachers felt the school situation and the teaching profession would get worse, 29 percent felt it would stay the same, and 43 percent anticipated it would improve.

"FUTURES-DRIVEN EDUCATION"

The Indiana Department of Education issued a statement on "futures-driven curricula" in their "Local Schools Use of the Indiana Proficiency Guides" publication (unpublished initial draft, 1986). That section stated, "The lecturing of facts to students will certainly lose its usefulness. With information readily accessible, the task of education is to provide opportunities for students to develop skills in accessing and using information...." Content is not totally abandoned, the guidelines state, "...but becomes the matrix to be manipulated...We must think about something...and that is where information comes in." The Indiana Academy of Science responded in the 1988 annual meeting with the following resolution:

> WHEREAS the subject matter of the sciences, such as factual content and concepts is based upon skills for observation, experimentation, and thinking, and since both subject matter and skills are necessary to the science and science education, and WHEREAS state educational proficiency statements for science now indicate only the skills expected of a student, rather than skills *and knowledge base* as mandated by IC 20-10.1-16-1, BE IT RESOLVED that the Indiana Academy of Science recommend to appropriate state officials that proficiency statements be established for a knowledge base of science, in addition to the proficiency statements for skills of science..., and BE IT RESOLVED that the Indiana Academy of Science recommends to these state officials that the Indiana Statewide Testing for Educational Progress include components which evaluate knowledge of subject matter in science separately from evaluation of science skills.

The action by the Indiana Academy of Science may be a unique case where a group of scientists publicly opposed the trivialization of content knowledge in public school curricula.

BIOLOGY TEACHER SUPPLY

In the last 20 years, the percent of college graduates entering teaching has dropped from 24 percent of total graduates to 4 percent and then risen in the last four years to about 6 percent and leveled off. Some of this decline has been attributed to new vocational opportunities for women, with medicine and law draining off some of the most capable students, who would otherwise have entered teaching. While teaching still attracts some high achievers, numbers show that today's teaching candidates are, on the average, being drawn from a "lower cut" of the student population than before.

To determine if biology teacher production in 1989 has returned to 1968 levels and to assess the amount of biology content preparation for secondary biology teachers, a simple one-page query was sent to Indiana colleges and universities. In addition, Gary Gray, Manager of Data Base Systems for the Indiana Commission for Higher Education, provided numbers of college students certified under the "classification of instructional programs" (CIP) number 131316 (science education) and CIP-number 260101 (biology). These figures, summarized in Table 3, indicate that biology teacher production is about one-fourth the 1968 level. Additionally, larger research universities in Indiana generally have below-average biology content in biology teacher programs, a feature also found for Kansas (Schrock, 1989). One respondent noted that students who pursued

Table 3. Biology teacher production at Indiana colleges and universities as self-reported for 1989 (and State data for 1988, personal communication with Gary Gray, Indiana Higher Education Commission).

	Number of graduates 1989	Number of sem. hours "Majors"	Number of sem. hours "Minors"	Production compared to 1968
Ball State University				
(State data, 1988)	12	--	--	--
Earlham University	2	30	30	lower
Grace College				
(State data, 1988)	3	--	--	--
Hanover College	2	8 courses	--	--
Huntington University	1	34	--	--
Indiana State University	5	24	19	1/4
Indiana University-Bloomington	35	24	15	1/4
Indiana Wesleyan University	0	30	15-16	1/2
Manchester College				
(State data, 1988)	2	--	--	--
Saint Joseph College	0	36	15	same
Southern Indiana University	2-3	24	--	NA
Taylor University	2	35-37	25-27	1/4
(State data, 1988)	3	--	--	--
Tri-State University	0	45 qt. hrs.	16?	NA
(State data, 1988)	1	--	--	--
University of Indianapolis				
(State data, 1988)	5	--	--	--
Valparaiso University	3	28-32	24	1/4
Wabash College	0	36	20	varies

NA = not applicable (no program in 1968).

the stronger liberal arts and science program and then decided to gain teacher certification were generally better teacher candidates, and that students certified through the School of Education route "...do not receive enough science to become effective teachers unless they are good students with the capacity to learn through independent

study." This problem of weaker content programs in larger universities may be due to schools of education or teacher's colleges maintaining more control over their teacher training programs and to research university content faculty preoccupation with research and graduate teaching.

A shift in biology teacher training has also occurred, with most teachers coming from the largest university and its branch campuses, but with several small new campuses now producing teachers. The mid-size universities that were the traditional normal school or teacher's college for Indiana are not as dominant as they once were. Ball State University, which in the mid-60's probably produced the most teachers in the U.S. when both bachelors and masters degrees are counted, operates at one-fourth that production today.

ORGANISMIC BIOLOGY

A major factor impacting the nature of biology training received by Indiana biology teachers is the rapid conversion from organismic to molecular biology at Indiana colleges and universities (Schrock, 1989). In a survey published earlier this year, organismic biologists on 1968 and 1988 biology faculties at Indiana colleges and universities were tallied based on catalogs and faculty member reports. The subjective analysis concluded "...in at least half of Indiana colleges, zoology and botany courses appear to be taught by biochemists, theoretical ecologists, and other biologists not familiar with the life history and systematics of organisms."

While the effect of changing biology departments into "gene-splicing companies" includes both a loss of collections and library subscriptions and an increase in textbook and research errors in organismic biology, the major concern remains the training of biology teachers in biochemistry while shortchanging organismic biology. In 1988, a motion "That the Indiana Academy of Science urge both the Indiana State Department of Education and the National Science Teachers Association to no longer approve secondary biology teacher programs at Indiana colleges and universities that do not interface secondary pre-service teachers with one bona-fide zoologist and one bona-fide botanist in their college coursework" did not survive the Indiana Academy of Science Resolutions Committee. "Bona-fide" zoologists and botanists were defined as biologists with an understanding of the systematics of the appropriate group, including a demonstrated ability to identify organisms, and with a working knowledge of the life history and whole-organism biology of some members of that group.

CONCLUSION

For Indiana scientists to gain a representative view of the condition of science education in Indiana, it is necessary to examine objective data portraying the actual conditions of science learning in the state. Some surveys are seriously inflated, while others fail to ask questions that yield relevant information. Anecdotal cases provided by public school science teachers, who attend Indiana Academy of Science meetings,provided the first indication of the seriousness of many trends in Indiana, including abandonment of blood-typing labs, reducing field trips because of time-on-task regulations, and the many unintentional negative effects from the new science graduation requirements.

State Department of Education staff and public school administrators need to clearly resolve whether time-on-task regulations can legitimately be used to curtail science field trips, and this needs to be broadly communicated to the extent necessary to deny legitimacy to misrepresentation. Preservice and inservice programs need to provide teachers with in-depth professional understanding of copyright regulations for print and other media sufficient to make blanket school regulations unnecessary.

Some concerns, such as the restriction of scientific collecting permits for teaching use, will require a larger survey to reach a sufficient numbers of teachers, who taught 20 years ago when such permits were available. It is also too soon to assess the impact of the American Association for the Advancement of Science report recommendation to "teach less science" or the new National Association of Biology Teachers' position discouraging dissection in the classroom.

Future surveys need to address a wider range of issues affecting sciences other than biology. A more detailed probe should be made of lab safety concerns and liability cases. In areas of rapid change, such as AIDS and creationism/evolution, the same questions need to be used again to measure the change in reported practices over time. The well-intentioned state proficiency levels hold the potential of reducing science classes to teach-to-the-test assembly lines, and their effect needs to be monitored closely. Just as physicians best know the state of citizens' health, classroom science teachers are the richest source of information on Indiana science education.

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