

## WHAT ARE STUDENTS TAUGHT ABOUT EVOLUTION?

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**ABSTRACT.** According to reports from 1,441 undergraduate students at a large, public American university, most high-school biology teachers teach evolution. Approximately 25% of students who attended public schools report that their biology teachers also taught creationism, despite the fact that doing so is unconstitutional. When biology teachers teach creationism, they usually present only a particular version of the Judeo-Christian creation story, and often present this story as a scientific alternative to evolution. One-fifth of students who attended public schools report that their biology teachers taught them neither evolution nor creationism. Biology teachers at private schools may be more likely to teach evolution than are biology teachers at public schools. These results, which are discussed relative to the evolution/creationism controversy, indicate that creationism is far from extinct in biology classrooms.

### QU'ENSEIGNE-T-ON AUX ÉTUDIANTS À PROPOS DE L'ÉVOLUTION ?

**RÉSUMÉ.** Selon des témoignages recueillis auprès de 1 441 étudiants de premier cycle d'une importante université publique américaine, la plupart des professeurs de biologie au secondaire enseignent l'évolution. Environ 25 % des étudiants qui ont fréquenté des écoles publiques affirment que leurs professeurs de biologie ont aussi enseigné le créationnisme, même si cet enseignement est interdit par la constitution. Lorsque les professeurs de biologie enseignent le créationnisme, ils ne présentent habituellement qu'une version particulière de l'histoire judéo-chrétienne de la création, et relatent souvent cette histoire comme si elle était une autre possibilité scientifique de l'évolution. Un cinquième des étudiants qui ont fréquenté des écoles publiques souligne que leurs professeurs de biologie ne leur ont pas enseigné l'évolution ni le créationnisme. Les professeurs de biologie des écoles privées peuvent être plus susceptibles d'enseigner l'évolution que leurs homologues des écoles publiques. Ces résultats, qui font l'objet de discussions relativement à la controverse liée à l'évolution et au créationnisme, montrent que le créationnisme est loin d'être disparu des salles de classe de biologie.

## INTRODUCTION

One-third of American adults reject evolution, another 55% have tentative views of evolution, and only 14% consider evolution to be “definitely true” (Miller, Scott, & Okamoto, 2006). These results are consistent with a variety of other studies of the American public’s views of evolution and creationism (e.g., Duncan & Geist, 2004, and references therein). Indeed, in a recent study of the public’s acceptance of evolution in 32 European countries, only Turkish adults were less likely to accept the concept of evolution than were American adults (Miller, Scott, & Okamoto, 2006). This widespread skepticism and rejection of evolution by American adults has occurred despite decades of science education “reform,” as well as the facts that evolution is 1) the foundation of biology, 2) supported by overwhelming amounts of evidence from a variety of different scientific disciplines, and 3) endorsed (and creationism is rejected) by all professional organizations of scientists and most science teachers. In the public schools of many states, the teaching of evolution is mandated by the states’ science-education standards (Cavanagh, 2005a; Gross, 2005). Why, then, do so many students question, reject, and know so little about evolution? Evolution is supposed to be taught in U.S. high schools, but is it? If evolution is taught, how is it taught?

The purpose of this study was to characterize what students in U.S. high schools are taught about evolution. I wanted to answer several questions. For example, what percent of teachers teach evolution? What percent teach creationism? What percent teach both? What percent teach neither? How do these data from public schools compare with those of private schools? If biology students in public schools are taught creationism, what are they taught?

## METHODS

From 2003 to 2006, I surveyed 1,441 undergraduate students enrolled in a large introductory biology course at the Twin Cities campus of the University of Minnesota. These students came from throughout the Midwest, and particularly from Minnesota. They had an average ACT score of 23, an average age of 19, and on average graduated high school in the 53<sup>rd</sup> percentile. Male and female students were represented approximately equally, and the ethnic diversity of the sample was as follows: 53% Caucasian, 19% African American, 2% American Indian, 19% Asian American, 4% Hispanic, and 3% undeclared.

The survey included three multiple-choice questions and two open-ended questions. The multiple-choice questions were as follows: 1) Did you attend a public high school or private high school? 2) Did you take biology in high school? and 3) If you took biology in high school, did your biology class emphasize a) evolution but not creationism, b) creationism but not evolution,

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c) both evolution and creationism, or d) neither evolution nor creationism? Answers to these questions were tabulated electronically.

The two open-ended questions on the survey were as follows: 1) If your high school biology course emphasized creationism, how was creationism presented?, and 2) If your high school biology course emphasized creationism, which, if any, creation stories were included? Answers to these questions were grouped into the general categories listed in Table 1.

All surveys were anonymous, voluntary, had no impact on students' grades, and were distributed and collected at the beginning of the first class of the semester (i.e., before any instruction). Students whose high school biology courses were not "general biology" (e.g., those who instead took courses such as anatomy or medical technology), as well as those who could not recall the content of their high school biology courses, were instructed to not answer the questions. More than 97% of the students completed the survey.

### RESULTS

Virtually all (99%) of the students in this survey took biology in high school. Ninety-five percent of the respondents had attended a public high school; 5% had attended a private high school. More than 90% of the students who attended private high schools reported that their schools were affiliated with religious organizations.

Students' characterizations of their high school biology courses are shown in Table 1.

	Public	Private
My high school biology course emphasized		
Evolution but not creationism.	54	34
Creationism but not evolution	3	15
Both evolution and creationism	22	51
Neither evolution nor creationism	21	0
If your high school biology course emphasized creationism, how was creationism presented?		
Scientific alternative to evolution	51	31
Another explanation (not necessarily scientific) for life's diversity	24	4
An idea "equal" to evolution	16	2
Religious explanation of life's diversity	6	63
Other	2	0
If your high school biology course emphasized creationism, which, if any, creation stories were included?		
Only the Christian story	73	88
Several stories or generic stories	23	12
Only the Islamic story	2	0
Only the Hindu story	1	0
Only the Native American story	1	0

TABLE 1. How students from a university in the Midwestern U.S. characterize their high school biology courses. Numbers in the table are percentages of students who chose each answer.

In public schools, most students were taught evolution but not creationism. In private high schools, most students were taught both creationism and evolution, but substantial percentages were taught evolution and not creationism.

A slight majority (i.e., 51%) of students from public high schools who were taught creationism reported that they were taught that creationism is a scientific alternative to evolution; progressively smaller percentages were taught that creationism is another, and not necessarily scientific, explanation of life's diversity (24%), an idea "equal" to evolution (16%), or a religious explanation of life's diversity (6%). Most (i.e., 63% of) students in private high schools who were taught creationism reported that they were taught that creationism is a religious idea; a much smaller percentage (i.e., 31%) reported that they were taught creationism as a scientific alternative to evolution. Although there are countless creation stories (Leeming & Leeming, 1994), high school biology teachers in public and private schools who teach creationism usually present only a particular version of the Judeo-Christian story of creation; other stories are usually ignored.

The survey generated much discussion and many questions every semester that it was administered. Many students commented about the questions and wanted to discuss the results. These and similar surveys have been effective ways to generate discussions about evolution and related topics both in and outside of the university classroom.

## DISCUSSION

### *Limitations of the study*

Like all survey-based research, this study had several possible limitations. Although I gathered data from a large and diverse group of students over several years, all of the students in this study attended the same university, and therefore are probably not a truly random sampling of all high school graduates (e.g., this study did not include any high school students not in college, nor did it include any students from other colleges and universities). Similarly, some of the students may have attended the same high schools, and hence the practices of some teachers may have been reported more than once in this survey. Also, 3% of the students could not remember much about their high school biology class and did not complete the survey; perhaps these students' high school biology classes were not similar to those reported in Table 1. Finally, students' perceptions of "creationism" may have differed, and their memories of their high school biology courses may not have been entirely accurate; for example, perhaps some of them discussed creationism in comparative religion and/or philosophy courses, and not in their biology course.

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### *How representative are these results?*

Despite these possible limitations, much evidence suggests that the data reported here are reliable and representative. For example, the sample size was large and diverse, only 3% of students did not complete the surveys, and the results were similar each semester. Moreover, the responses reported here by students are consistent with those reported by biology teachers in Minnesota (Kraemer, 1995; Moore, 2004c; Moore & Kraemer, 2005) and elsewhere (Aguillard, 1999; Randak, 2001; Rutledge & Mitchell, 2002; Tattina, 1989; Trani, 2004; Weld & McNew, 1999). As is true in many other states, the state science education standards of Minnesota (i.e., where most of the students in this study attended high school) mandate the teaching of evolution, and Minnesota's professional organizations of science teachers (e.g., Minnesota Science Teachers Association) endorse the teaching of evolution and reject the teaching of creationism (Moore, 2004c).

### *Evolution education in public schools*

If the reports from these students are representative of what teachers are teaching, more than half (i.e., 54%) of biology teachers in public schools teach evolution and not creationism (Table 1). That is, these teachers comply with the state educational guidelines and recommendations from professional organizations of science teachers (e.g., "Teaching biology in an effective and scientifically honest manner requires that evolution be taught in a standards-based instructional framework with effective classroom discussions and laboratory experiences"; National Association of Biology Teachers, 2004). Although almost 60% of these teachers devote at least six classroom hours to evolution, relatively few of them are pressured to teach evolution (Moore & Kraemer, 2005).

Furthermore, although only 3% of biology teachers at public schools teach creationism and not evolution, more than 20% of biology teachers at public schools teach both evolution *and* creationism. That is, 29% [i.e.,  $22/(22 + 54)$ ] of the total number of public-school teachers who teach evolution also teach creationism in their biology courses. Similar percentages have been reported in other studies (Moore & Kraemer, 2005, and references therein), and the amount of class time devoted to creationism in public schools is increasing (Moore & Kraemer, 2005).

A surprising percentage of high school biology teachers are creationists, and the teaching of creationism by biology teachers in public schools is not new – comparable data have been reported for several decades (e.g., Kibbler, 2001; Muller, 1959; Nelkin, 1982; Riddle, 1941; Troost, 1979). Today, the membership of the National Science Teachers Association drops when the word *evolution* appears on the cover of one of its journals (Moore & Kraemer, 2005; D. Beacom, personal communication, 2004). Don Aguillard, the lead

plaintiff in *Edwards v. Aguillard* (1987), was correct when he noted that “Creationism is alive and well among biology teachers” (Moore, 1999).

The teaching of creationism in biology classes of public schools – regardless of whether it is accompanied by the teaching of evolution – is unconstitutional (e.g., *Edwards v. Aguillard*, 1987; *McLean v. Arkansas Board of Education*, 1982). But if the teaching of creationism is unconstitutional and violates states’ science-education guidelines, why do so many biology teachers in public schools continue to teach creationism? There are several likely reasons:

*Pressure to teach creationism and/or avoid evolution.* Large percentages (i.e., 30-50%) of biology teachers are pressured to teach creationism and/or avoid evolution (Cavanagh, 2005b; Kraemer, 1995; Moore, 2002a; Verango & Toppo, 2005; Zimmerman, 1987). This pressure, which has increased during the past decade, is much more likely to come from parents than from administrators or other people (Moore & Kraemer, 2005). Anti-evolution pressure from the public is also felt by educational organizations and science museums (Marks, 1998; Moore, 2004b)

*Teachers’ poor understandings of evolution and the nature of science.* Teachers who have a better understanding of evolution and the nature of science allocate more time to evolution and do a better job of teaching it (Rutledge & Mitchell, 2002). In Minnesota and many other states, most biology teachers claim that they are not prepared to teach evolution (Kraemer, 1995; Moore & Kraemer, 2005; Tatina, 1989; Zimmerman, 1987). This may be due to the fact that most future biology teachers do not take courses that focus on evolution (Rutledge & Mitchell, 2002; Rutledge & Warden, 2000). For example, many biology teachers in Louisiana do not recall hearing the word *evolution* in the college biology courses, apparently because many biology professors do not teach evolution (Moore, 2002a).

*Teachers’ rejection of evolution and/or support of creationism.* Teachers’ understanding of and personal views about a subject affect their teaching (Carlesen, 1991; Grossman, 1989); almost one-fourth of Minnesota’s biology teachers believe that creationism has a valid scientific foundation (Moore & Kraemer, 2005). Similarly, 15% of biology teachers believe that evolution is not a scientifically valid idea (Moore & Kraemer, 2005).

*Teachers’ poor understanding of the law.* More than one-fourth of high school biology teachers at public schools do not know that it is unconstitutional to teach creationism in their classes. These teachers mistakenly believe that it is lawful to teach creationism if they also teach evolution (Moore, 2004a).

*The lack of consequences for teaching creationism.* Creationism has been taught in 20-30% of public school biology classrooms for several decades. Although these creationists have occasionally been reassigned (e.g., Rod LeVake; see Moore, 2004b), most pro-creationism teachers continue to teach creationism with no consequences.

*Teachers’ religious beliefs.* The teachers most likely to include creationism in their courses are also most likely to have strong religious convictions; few, if any, teachers reject evolution because of non-religious reasons (Trani, 2004, and references therein). Individuals with the strongest religious beliefs are most likely to reject evolution (Lawson & Worsnop, 1992).

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Although there are many different creation stories (Leeming & Leeming, 1994), most students in this study whose high school biology teachers taught creationism reported that creationism was presented to them as a scientific alternative to evolution. That is, most teachers who teach creationism do not present creationism as a philosophical or religious idea, but instead teach “creation science” – namely, that the Biblical story of creation is a scientific explanation of life’s diversity. This approach, which was popularized in the 1960s by *The Genesis Flood* (Whitcomb & Morris, 1961), has been rejected by scientists and the courts alike, yet remains the foundation for well-funded anti-evolution organizations such as Answers in Genesis and the Institute for Creation Research (Cole, 2000; Moore, 2002a). The most popular beliefs of undergraduates are theistic evolution and intelligent design creationism; “young earth” creationism – a hallmark of creation scientists – is endorsed by fewer than 1 in 10 undergraduates (Moore, in press)

My finding that most public school biology teachers who teach creationism teach “creation science” is consistent with the facts that 1) more than 20% of biology teachers believe that creationism has a valid scientific foundation (Kraemer, 1995), and 2) almost 30% of biology teachers believe that they may give equal time to creationism if they also teach evolution (Moore, 2004b). Most biology teachers do not know that the U.S. courts have ruled that “creation science” has “no scientific merit or educational value as science [because it] is simply not science” (*McLean v. Arkansas Board of Education*, 1982; Moore, 2004a). Although 80% of biology teachers acknowledge that the teaching of creationism brings religion into the classroom (Kraemer, 1995), only 6% of public school biology teachers who teach creationism present creationism as a religious idea.

Approximately one-fifth of the students who attended public-schools reported that their biology teachers taught them neither evolution nor creationism (Table 1). Such teachers often claim that they do not teach evolution because they “run out of time” (Moore, 2004a). These results are consistent with the report by Kraemer (1995) that almost 40% of Minnesota’s biology teachers spend little or no time teaching evolution. This refusal to teach evolution, despite being mandated to do so by state educational standards, probably results from the same factors as those responsible for some teachers’ insistence on teaching creationism (e.g., pressure, poor training, etc.; see above).

#### *Evolution education in private schools*

Although biology teachers in public schools are ostensibly required to teach evolution, biology teachers in private schools often are not. Similarly, although it is unconstitutional to teach creationism in science classes of public schools, private schools are not legally barred from doing so. Nevertheless, the teaching of evolution in biology classrooms appears to be more common in private schools than in public schools (Table 1). Consistent with these

data were my interviews of several randomly selected teachers from private high schools (e.g., Cretin-Durham Hall, St. Thomas Academy), all of whom included evolution in their courses. These results suggest that, on average, students at private schools are more likely to be taught about evolution than are students at public schools. Although this study did not examine the quality of the evolution-related instruction (i.e., merely teaching evolution is not synonymous with teaching it effectively), there is no *a priori* reason to assume that evolution-related instruction in private schools is necessarily worse than that at public schools.

## CONCLUSIONS

1. Most high school biology teachers teach evolution and not creationism. That is, most teachers comply with state educational guidelines and the recommendations of professional organizations of science teachers.
2. Approximately 20% of students surveyed in this study report that their high school biology teachers taught them neither evolution nor creationism. These teachers ignore state educational standards' mandates to teach evolution.
3. Based on these students' reports, creationism appears to be taught in 20-25% of biology classes in public schools. When creationism is taught in public school biology classes, it is almost always taught with evolution. This teaching of creationism by public school biology teachers has occurred for several decades. John Scopes' observation in 1966 that "I don't think the world changes very rapidly" (Anonymous, 1966) certainly applies to the prevalence of the teaching of creationism by biology teachers.
4. When creationism is taught in public and private high schools, it is usually only a particular version of the Judeo-Christian story that is taught (although the teaching of creationism does not always involve the reading of Genesis; for example, it is often disguised as "creation science" or "Intelligent Design"). In public schools, this story is usually taught as a scientific alternative to evolution; in private schools, it is usually taught as a religious explanation for life's diversity.
5. Omitting the teaching of evolution may be less common at private schools than at public schools. Indeed, only 15% of students from private schools reported that they were not taught evolution. In contrast, 24% of students from public schools reported that they were not taught evolution.

In 1991, Eve and Harrold (1991) concluded that "over a quarter – and perhaps as many as half – of the nation's high school students get educations shaped by creationist influence – in spite of the overwhelming opposition of the nation's scientific, educational, and media establishments." Data presented here and elsewhere indicate that little has changed; surprisingly



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high percentages of high school biology teachers in the United States teach creationism. In public schools, this educational malpractice has undermined science, contributed to the ongoing popularity of creationism with the public, and cheated students out of an understanding of one of the greatest ideas in history (Moore, 2001; Moore & Moore, 2006).

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