

No Data Required: Why Intelligent Design Is Not Science

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ABSTRACT

Intelligent Design (ID) proposes that biological species were created by an intelligent Designer, and not by evolution. ID's proponents insist that it is as valid a theory of how biological organisms and species came into existence as evolution by natural selection. They insist, therefore, that ID be taught as science in public schools. These claims were defeated in the Kitzmiller case. However, ID's proponents are still influential and cannot be considered a spent force. The question addressed here is whether ID's claim of scientific legitimacy is reinforced by quantified results. That is, do they have any data, or do they just argue? The ID articles that I analyzed claimed to present real science, but they rarely referred to data and never tested a hypothesis. Argumentation, however, was frequent. By contrast, peer-reviewed articles by evolutionary biologists rarely argued but referred frequently to data. The results were statistically significant. These findings negate claims by ID proponents that their articles report rigorous scientific research. Teachers will find this article helpful in defending evolution, distinguishing science from non-science, and discussing the weaknesses of ID.

Key Words: Evolution; Intelligent Design; Creationism; science; content analysis; data; argue; Discovery Institute; science education; strengths and weaknesses; hypothesis.

○ Introduction

Intelligent Design (ID) is both the successor to Creationism and a cryptic manifestation of it. Proponents of ID have argued that their ideas about the origins of biological species are as scientifically valid as the theory of evolution by natural selection. On this basis they argue that ID should be taught as science. These claims have been widely refuted by biologists and were defeated in the Kitzmiller case (*Kitzmiller v. Dover Area School District*, 2005), but proponents of ID continue to

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insist that it is science. And they continue to have success in persuading legislators, school board members, teachers, and others involved in decisions regarding science education, both in the United States (Missouri House of Representatives, 2014; Ohio Legislature, 2014; Oklahoma State Legislature, 2014a, 2014b; National Center for Science Education, 2014b; South Dakota Legislature, 2014; Virginia General Assembly, 2014) and elsewhere in the world (National Center for Science Education, 2013, 2014a). Two states, Louisiana (Louisiana State Legislature, 2008) and Tennessee (Tennessee State Legislature, 2012), currently have laws allowing the teaching of Intelligent Design/Creationism in public schools. Therefore, ID cannot be considered a spent force.

ID's proponents point to the many, ostensibly scientific, articles and books that have been published on the subject. They insist that the question of how biological organisms and species came into existence therefore remains open. It has been pointed out that articles promoting ID tend not to appear in peer-reviewed scientific journals (Forrest & Gross, 2004). However, proponents of ID nonetheless claim that their work is valid science, and further claim that many of their articles are, in fact, "peer-reviewed."

Articles promoting ID often claim to present original research. However, they rarely contain descriptions of the methods by which research was done, or the experimental and/or quantitative results they have obtained. The explanation of scientific methods I give below makes it clear why this is important. Ideological concerns should not prevent publication, but the more important question is whether ID has produced any quantified results as evidence to reinforce its claims of scientific legitimacy. In other words, do they have any data, or do they just spend their time arguing?

Here, I address that question by analyzing articles written by ID authors and by evolutionary biologists, looking for evidence of quantitative reasoning. I outline how I generated my hypothesis, what I predicted as a result of my hypothesis,

the materials I used and how I obtained them, the procedures I followed, my results, a discussion, a conclusion, and suggestions for how this research may be useful to teachers and others involved in education.

To my knowledge, this is the first study of its kind that has been performed on articles promoting ID. The results I obtained are highly statistically significant. This suggests that other studies using similar approaches may be fruitful.

○ How I Generated the Hypothesis

The Roles of Measurement & Quantification in Science

Measurement and quantification are important parts of the scientific process (Jinks, 1997). Although scientific investigations in a given field may start with careful observational studies, measurement and quantification are expected to follow not long thereafter, if the field is to be productive. For example, the study of Acquired Immune Deficiency Syndrome (AIDS) began in 1981 with the observation that five gay men in the Los Angeles area had rare lung infections and generally weakened immune systems. By the end of that year, 270 gay men were reported with severe immune deficiencies. Further quantitative studies led to our understanding of the routes of transmission of AIDS, to the identification of Human Immunodeficiency Virus (HIV), to commercial diagnostic tests, and, by the year 2000, we had drugs that keep people alive with the disease over many years (AIDS.gov, 2014). At this point, we can estimate how many people have died when drugs have been refused (Chigwedere et al., 2008).

Thus, in 20 years, AIDS went from being unknown to being largely treatable. From a scientific standpoint, it went from being an observation that some homosexual men had unusual lung and immune problems to being a well-documented, understood, and largely treatable disease, all because hypotheses were tested and quantitative procedures were used.

Disagreements about the Idea of Intelligent Design as Science

Proponents of ID insist that it is science (Discovery Institute, 2015). The idea of the intelligent design of biological organisms was formally presented in 1802 by William Paley in his book *Natural Theology* (Paley, 1802), though he did not use the exact phrase “Intelligent Design.” More recently, it was proposed in 1984 in *The Mystery of Life’s Origin: Reassessing Current Theories* by Charles B. Thaxton, Walter L. Bradley, and Roger L. Olsen (Thaxton et al., 1984). The idea was further promoted in the school-level biology textbook *Of Pandas and People* (Davis & Kenyon, 1989), which was edited by Dr. Thaxton and first published in 1989. If something is being presented in a science textbook meant for school children, it is reasonable to assume that the field is well developed. Thus, it is reasonable to say that ID has been actively pursued for at least 25 years. This is enough time for a field of scientific enquiry to pass beyond the initial observational stages, and progress into hypothesis testing and quantification.

However, the majority of biological scientists do not consider ID legitimate science. It has been the experience of this author that ID articles do not read the way that articles in biological journals do. In a biological journal article, a subject is introduced, a hypothesis

is often described, the methods by which an investigation was done are explained, the results are given, and conclusions are expressed. ID articles frequently seem to this author to be all introduction. Particular viewpoints are described, and then argued for or against. This goes on for many pages, with new information generally not being introduced. The articles seem to be largely argument, and they generally do not even have a results section. This is very unlike articles in scientific journals.

Assessing Intelligent Design Articles

It is possible to do point-by-point refutations of ID articles, showing many ways in which they get facts wrong and arrive at erroneous conclusions. However, this can be tedious and time-consuming for general readers, so I decided to take a different approach: looking at ID papers as a body of work, to see whether they contain one of the basic elements of scientific research articles – *data*.

Data is something that science cannot do without. By contrast, argumentation in scientific papers, though present, is a fairly minor element. Different schools of thought may be mentioned in the introduction to a research paper, but only as a prelude, as a means of explaining why a particular investigation took place. The rest of the paper will describe methods, results, and conclusions. For this reason, I also decided to look at ID articles to see how much argumentation they contained.

Because I was going to investigate a large body of work, it seemed wise to set limits on the investigation. For this reason, I chose to search ID articles for two words only: the word *data* and the word-root *argu*. The latter word-root took in the word *argue* in its many forms – *argument*, *arguing*, *argumentation*, and so on. I understand that it is not necessary to use the word *data* in order to have data. For instance, the word *results* may be used instead. Nonetheless, from many years of experience, I know that scientific articles often use the word *data* when referring to the results that have been obtained. Likewise, words formed from the word-root *argu* are often used to describe differences of opinion. Other words, such as *contend* and *debate*, are also sometimes used, but scientific investigations are often best when they are simplest. Limiting the scope of this investigation to the words *data* and *argu* seemed like the most fruitful approach.

Obtaining Articles on Intelligent Design

The Discovery Institute is the leading institutional proponent of ID. They have a large website that describes their numerous activities. One part of their website is devoted entirely to what they say are scientific articles supporting ID. During my study, these articles were all available directly from the website and could be downloaded free of charge. These were the articles that formed the basis for my investigation, the articles I searched for *data* and *argu*.

The Discovery Institute has literally provided the language on which Creationism/ID-friendly laws are based. The Louisiana Science Education Act was based on language provided by the Discovery Institute (Washington Post, 2009; Gill, 2011). Likewise, Tennessee House Bill 368 was based on language provided by the Discovery Institute (Los Angeles Times, 2012; Weinberg, 2012). Both these laws allow and encourage Intelligent Design and Creationism to be taught as science in American public school classrooms. The Discovery Institute convinced these two state legislatures to consider ID/Creationism as science by referring to the supposedly scientific research articles on

their own website. Therefore, it was appropriate to concentrate on those articles in this investigation.

A Control Group: Peer-Reviewed Research Articles by Established Scientists

A control group was needed. Since ID claims to be science, it was necessary to compare the work of ID authors with that of known scientists. The fairest comparison, as I saw it, would be to the work of another institute; this one known for its high-quality scientific research. Because I had obtained the Discovery Institute's articles by downloading them from their website, it further seemed fair to obtain my control group's articles in the same way. For these reasons, I selected articles from the Smithsonian Tropical Research Institute (STRI), which is known for doing high-quality biological research and whose articles were all available online through their website. An entire section of the website was devoted to research in evolutionary biology, and I used these articles as the control group in my investigation.

○ Hypothesis & Prediction

ID writers often specifically claim to be doing scientific research. In fact, they write papers that may sound scientific to the untrained reader. They use many scientific-sounding words. My question was "Are they really doing science?" I approached this question by looking at the articles that ID writers at the Discovery Institute claimed were scientific research and asked a more specific question: "Do they primarily rely on data or on argumentation?" Reliance on data is a hallmark of scientific investigation, while reliance on argumentation is not. Reliance on argumentation may be the hallmark of other fields of scholarship such as philosophy, but it is not a hallmark of science.

My hypothesis was that these ID writers do not do scientific research. I predicted, therefore, that they would use the word-root *argu* more than they would use the word *data*. By contrast, the known scientific researchers at the prestigious STRI would use the word *data* in their articles more than they would use the word-root *argu*.

○ Materials Used

In order to perform this analysis fairly, I developed a set of rules for obtaining the articles. These rules were made in advance of my downloading the articles, so I could not base a decision to use or not use an article on whether or not I liked it. Specific pathways were used, based on the websites for the Discovery Institute and STRI as they existed in August of 2010. This careful selection process allowed a fair comparison between articles from the Discovery Institute and articles from STRI. All articles in this study were downloaded during August 9–11, 2010. Only articles in English were used.

Obtaining Intelligent Design Articles

ID articles were all obtained from the website of the Discovery Institute because it is the leading institutional proponent of ID. During my study, an entire section of its website was devoted to articles about ID produced by authors with whom the Discovery Institute was associated.

My exact procedure for obtaining articles from the Discovery Institute website was as follows. (1) I Googled the words "Discovery

Institute" and clicked on the Discovery Institute's website (Discovery Institute, 2010). (2) There, I clicked on the section labeled "Science and Culture," which brought me to the Center for Science and Culture website. (3) There, I found the heading "Scientific Research and Scholarship," under which was a subheading that read "Peer-Reviewed & Peer-Edited Scientific Publications Supporting the Theory of Intelligent Design (Annotated)," followed by a defense of this somewhat unusual designation:

Editors' Note: Critics of intelligent design often claim that design advocates don't publish their work in appropriate scientific literature. For example, Barbara Forrest, a philosophy professor at Southeastern Louisiana University, was quoted in *USA Today* (March 25, 2005) that design theorists "aren't published because they don't have scientific data."

Other critics have made the more specific claim that design advocates do not publish their works in peer-reviewed scientific journals – as if such journals represented the only avenue of legitimate scientific publication. In fact, scientists routinely publish their work in peer-reviewed scientific journals, in peer-reviewed scientific books, in scientific anthologies and conference proceedings (edited by their scientific peers), and in trade presses. Some of the most important and groundbreaking work in the history of science was first published not in scientific journal articles but in scientific books – including Copernicus' *De Revolutionibus*, Newton's *Principia*, and Darwin's *Origin of Species* (the latter of which was published in a prominent British trade press and was not peer-reviewed in the modern sense of the term). In any case, the scientists who advocate the theory of intelligent design have published their work in a variety of appropriate technical venues, including peer-reviewed scientific journals, peer-reviewed scientific books (some in mainstream university presses), trade presses, peer-edited scientific anthologies, peer-edited scientific conference proceedings and peer-reviewed philosophy of science journals and books.

We provide below an annotated bibliography of technical publications of various kinds that support, develop or apply the theory of intelligent design. The articles are grouped according to the type of publication. The first section lists featured articles of various types which are of higher interest to readers, which is then followed by a complete list of the articles. The featured articles are therefore listed twice on this page (once in the featured articles section and again below in the complete list).

These paragraphs were followed by the heading Featured Articles – the papers that the Discovery Institute itself claims are scientific research. Put simply, I took the Discovery Institute at its own word – these are the articles that the Discovery Institute says are its scientific research articles, so I treated them that way. I copied each featured article in turn, starting with the first one. I obtained all the ID articles included in my study exclusively from this section of the Discovery Institute website.

Because this study was interested only in original scientific research, I rejected review articles and books, though chapters of books that the Discovery Institute claimed were original research were included. All articles from this section of the Discovery Institute's website that met these criteria were used. In each case, the entire article was analyzed, including the abstract (if there was

one) and the captions of tables and figures (if any). I did not include reference lists in the analysis.

Evolutionary Biology Articles

The articles in the control group were all obtained from the website of STRI. As stated above, STRI is known as a producer of high-quality scientific research. My exact procedure for obtaining these articles was as follows. (1) I Googled the Smithsonian Institution (Smithsonian Institution, 2010). Then I clicked on (2) the Smithsonian's Home Page, (3) "Research" at the top of the Home Page, (4) "Tropical Research Institute (STRI)," (5) "Programs" at the top of that page, and (6) "Evolution" on the left-hand side of that page, which led to an entire section of the website devoted to research articles about evolutionary biology, produced by authors with whom STRI was associated. There was a list, in alphabetical order, of STRI scientists who had published papers on evolutionary biology. From there, one could click on each scientist's name, and a list of articles became available.

The articles were listed in chronological order of publication, starting with the most recent articles. These were all available for downloading. Only papers from STRI that were listed by the institute under the category of Evolution and that had been published in peer-reviewed scientific journals were considered. Of these, only original research articles were used. Reviews, review articles, and books were not included. Of the original research articles, exactly four per author were used, and they were the first four by each author that met these criteria (so that more prolific authors would not be overrepresented in the sample). The entire article was analyzed, including the abstract (if there was one) and the captions of tables and figures (if any). I did not include reference lists in the analysis.

Methods

I analyzed a total of 63,024 words in 11 articles from the Discovery Institute and 143,172 words in 28 articles from STRI. In both cases, the articles were copied entirely and then pasted into a separate document. After all the articles had been copied, with the Discovery Institute articles placed in one document and the STRI articles in a different one, the content analysis began. I used the "Find" tool in Microsoft Word to search each compilation of articles, first for *data* and then for *argu*. I went through each article personally, using the "Find" tool.

When counting the instances of the word *data*, all words with the root *data* were chosen when they referred to quantitative results, such as *data* and *database*; words containing *data* in reference to organisms, such as *chordata*, were excluded. As stated above, I used only the content of the articles, including titles and captions, and excluded everything in the reference sections.

When counting instances of the word-root *argu*, all words containing the root *argu* were used, when they referred to persuasion and disputation. These included the words *argue*, *argument*, and *arguing*, for example. Again, the content of the articles, including titles and captions were analyzed, and reference sections were excluded from analysis.

Results

Among the 63,024 words from the Discovery Institute and 143,172 words from the Smithsonian Institute for Tropical Research that were analyzed, the word frequencies were as follows: The word-root *argu* was used 88 times in the articles from the Discovery Institute, but only 11 times in articles from STRI. By contrast, *data* was used 270 times in the STRI articles, but only 24 times in articles from the Discovery Institute. These results are shown in Table 1 and Figure 1.

Statistical Analysis

I performed a Pearson's chi-square analysis on these results. The chi-square test is appropriate for categorical data such as these. Moreover, the sizes of the control and experimental populations do not have to be the same when the chi-square test is used (McHugh, 2013). The result of this analysis was extreme: $P < 1.9 \times 10^{-53}$. It is therefore very unlikely that the differences reported here are a result of random chance.

Table 1. Numbers of times that the word-root *argu* and the word *data* occur in 11 articles from the Discovery Institute and 28 articles from the Smithsonian Tropical Research Institute.

	<i>argu</i>	<i>data</i>
Discovery Institute	88	24
Smithsonian Tropical Research Institute	11	270

Note: The numbers in the upper left quadrant and the lower right quadrant are both very high, while the numbers in the upper right and lower left quadrants are very low; these strong diagonals are an indication of statistical significance.

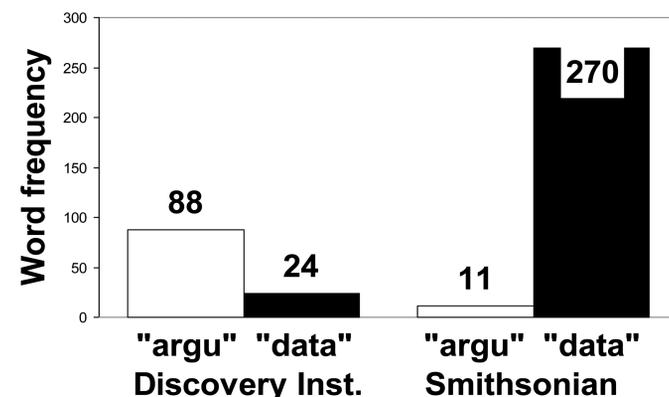


Figure 1. Numbers of times that the word-root *argu* and the word *data* occur in 11 articles from the Discovery Institute and 28 articles from the Smithsonian Tropical Research Institute (STRI). Scientists at STRI made heavy use of data but rarely used or cited argumentation in their articles. By contrast, Discovery Institute writers rarely referred to data, and never to testing a hypothesis, but they referred heavily to argumentation. The difference is significant ($P < 1.9 \times 10^{-53}$).

Further Analysis

The above results alone seriously damage ID's claim to be a well-developed branch of science. The rarity of references to quantified data in these articles indicates a field that is either not well developed as a science or is not a science at all. However, it seemed appropriate to take this investigation a step further and examine every instance in which Discovery Institute authors used the word *data* at all, to see whether this usage ever referred to testing a hypothesis. After all, a field of science well developed enough to merit inclusion in science textbooks and instruction should be well developed enough to have done some hypothesis testing.

In essence, I was giving ID another chance. If any of the Discovery Institute's references to data had led me to a report of active hypothesis testing, it would at least indicate that some writers at the Discovery Institute were attempting to do legitimate scientific research. One or two tested hypotheses would not alone make ID worthy of inclusion in biology textbooks, but it would at least indicate integrity on the part of the Discovery Institute writers who claimed that they were doing valid research.

Results of Further Analysis

I found that out of the 24 instances in Discovery Institute-published papers in which the word *data* was used, 19 referred to data generated by other people, usually data on Cambrian fossils. This was not active scientific research. These articles simply talked about other people's work, without any predictions or testing being done by the authors of the ID articles. Of the remaining five articles, four referred to data as a concept. That is, they talked about what data might look like, if they had any. Finally, there was one paper that had original data, but there was no hypothesis testing. In short, in all of the purportedly peer-reviewed ID literature that the Discovery Institute had published, there was not a single instance of hypothesis testing.

○ Discussion

Science is a method of investigation that is used to obtain a better understanding of reality. It involves a series of rules and methods that are needed to move forward in this process. In addition to the careful observation and quantification mentioned earlier, science makes further demands on its investigators. I have listed some of these further requirements below (University of California at Berkeley, 2014).

Hypotheses, Predictions, and Falsifiability. At some point in the development of a given field, hypotheses must be produced, and predictions based on these hypotheses, that are testable at least in principle, must be produced. If there is no way that an idea could ever be tested, at least in principle, then it falls outside of the realm of science. It must further be possible to design a test of the hypothesis that would prove that the hypothesis is wrong. This is called *falsifiability*.

Reproducibility. It must be possible for other investigators to get the same results, if they carefully use the same methods of investigation. That is, for results to be accepted, they must be reproducible.

No Supernatural Explanations. Another important rule is that science cannot resort to the supernatural for explanations. This

stipulation has allowed science to advance in ways that would have been unthinkable had supernatural explanations been allowed. Invoking a deity may seem like a reasonable idea at times, but it is a nonproductive one. Our knowledge of the natural world has progressed specifically because science has rejected supernatural explanations for phenomena, and sought real ones. Verifiable explanations based on reality have then been found. If supernatural explanations of natural phenomena had been accepted, then further research, which led to correct, non-supernatural answers, would never have been done. For instance, referring back to the history of AIDS that I outlined earlier, if scientists had accepted that the cause of AIDS was the wrath of a deity, we would never have discovered HIV, which is the real cause of AIDS.

Intelligent Design, Supernatural Explanations, & Predictability

ID breaks a number of the rules that I have listed above. First, and obviously, it resorts to supernatural explanations. That, in fact, is entirely what ID is – a supernatural explanation for how biological species came into being, in contrast to the non-supernatural explanation given by evolution by natural selection. Second, by resorting to supernatural explanations, it would appear that ID makes prediction impossible. This is not simply an assertion on my part. Dr. William A. Dembski, a Senior Fellow at the Discovery Institute's Center for Science and Culture, has written the following: "Yes, Intelligent Design concedes predictability" (Dembski, 2001).

Intelligent Design, Quantification, & Experimentation

Despite admissions by its proponents that ID is a supernatural explanation and that it concedes predictability, these proponents still insist that ID is science and should be taught in American public schools as such. They base this extraordinary claim on written work by ID proponents, which they say is scientific research. Much of the work sounds scientific to the untrained reader, since it addresses scientific and technical subjects and uses scientific terminology.

So, supposing for a moment that supernatural explanations are possible, how would a scientist find this out? By doing careful observations and controlled experiments, in order to show that no explanation other than the supernatural one is possible. It is reasonable to expect that a field that has been in existence more than 25 years – and that expects its work to be taught to school children in science classes and placed in textbooks – would have completed many carefully controlled, quantified experiments to back up their extraordinary claims.

One would expect to see a plethora of experimental data, and a corresponding plethora of references to it. Instead, my research has shown that even the Discovery Institute, the leading institutional proponent of ID, could find no experimental results with which to justify their claims. If the Discovery Institute did have any experimental evidence to show for its efforts, it would certainly publicize that material. Not only do they have no experimental results to show for 25 years' worth of writing, they rarely even refer to data, which is the lifeblood of any developed scientific field. The comparison between how the bona fide scientists at STRI wrote their papers versus how the writers at the Discovery Institute wrote them

makes it uncomfortably clear that the latter have not been doing scientific research.

○ Conclusion

Proponents of Intelligent Design claim that it is science. The results here, gleaned from their own writings, strongly contradict this claim. Yet the claim that ID is valid science is having a profound effect on how science is taught in this country as well as overseas – for instance, in Brazil and Turkey. Legislatures, the writers of state science standards, school boards, teachers, and parents are too often persuaded by the scientific-sounding language used by ID proponents.

The results presented here are strong evidence that ID cannot be considered a scientific discipline because it does not follow the basic requirements for scientific research. First, it is a supernatural explanation. Second, it cannot be used to make predictions. Third, it relies on argumentation rather than on data and the testing of hypotheses. Given these drawbacks, it is clear that ID writers at the Discovery Institute were not doing scientific research. It may be appropriate to consider their work scholarship, perhaps of a philosophical nature, but it is not science. Likewise, instruction regarding the idea of ID might be appropriate in a class on the history of ideas, but not in a science class.

It should be reiterated that the ID papers analyzed here are the ones the Discovery Institute specifically listed as their scientific research papers, not opinion papers. This makes it clear that the Discovery Institute does not readily distinguish between fact and argument.

These results can inform the debate as to whether or not ID should be included in a science curriculum. The method used here may prove useful in further studies of this kind. Below, I discuss a number of ways in which the information in this article will be useful to teachers.

○ How This Information Can Be Used in the Classroom

Defense of Teaching Evolution

This study's results provide a straightforward defense of teaching evolution and not Intelligent Design. Rather than having to refer to point-by-point refutations of ID articles, which can be tedious for most general readers and listeners, a teacher can point to this study, which examines many of ID's said-to-be-scientific articles, and point out that ID isn't science.

There is very little data in articles by ID writers and lots of arguing, whereas true scientists do the reverse. A complete lack of hypothesis testing points to a field that is at best undeveloped, since ID proponents have had more than adequate time to progress to quantified studies and hypothesis testing. The fact that they haven't done this despite 25 years of constant arguing, publicity, and lobbying for their views indicates a far greater interest in arguing, publicity, and lobbying than in doing authentic scientific research.

The fact that ID proponents want their ideas to be a part of biology textbooks before they have produced a large body of

quantitative research indicates that they either do not understand what science is or do not care. In either case, it indicates a cavalier attitude toward science that makes it even less likely that they are doing serious scientific research.

This will be a useful study for teachers to know about. It will also be very useful to school board members and those who deal with school boards; and to legislators and those who deal with legislators. All these individuals may need some useful quick references when dealing with other individuals who are inclined to accept ID.

If school board members, legislators, and others who control school curricula really want to insert ID into school curricula on the grounds that ID is science, then it is very important to establish that ID is not science. This is important both from the standpoint of teaching legitimate science in science classes, and from the standpoint of constitutional separation of church and state.

Scientific Literacy

Science is becoming an increasingly important and inescapable aspect of people's lives. People are required to research different types of drugs that they may need, to understand articles on water quality, and to decide whether or not to vaccinate their children. These are just a few ways in which written information about science affects people's lives.

An exceedingly important part of scientific literacy is the ability to distinguish science from non-science. It can be particularly difficult to distinguish science from non-science when an article or story on television is about science and uses scientific-sounding words. It is necessary to train students to look for objective evidence, hypothesis testing, and other hallmarks of scientific research.

This is particularly important at present because scientists are sometimes having their findings attacked for political reasons. In addition to evolution, this is true for climate science, especially global warming. Creation of doubt, based on argumentation rather than on careful research, is one of the many ways in which scientific results are called into question for nonscientific reasons.

Many science teachers at both the high school and college levels give assignments that involve reading popular media (newspapers, magazines, blogs, and so on) for articles on scientific subjects. A useful element in this type of instruction would be to have students analyze articles for scientific quality, as well as simply stating what the article is about. This is often easier than it sounds. Here are some simple questions to ask regarding any article about science:

- Does the article refer to data, or does it just argue?
- Is anything quantified?
- How were the data, if any, obtained?
- Were conditions controlled, and if so, how?
- Is anything testable, or tested?

This article can be used as a starting point in a discussion about how to evaluate writing about science. One approach would be to print an article from the "Peer-Reviewed & Peer-Edited Scientific Publications Supporting the Theory of Intelligent Design" section of the Discovery Institute website, and contrast it with an evolutionary biology article from STRI. The differences were, to this

reader, striking enough to start her on a new line of research, and I suspect that the differences would be obvious to high school and college students as well.

Strengths & Weaknesses

If a teacher is unfortunate enough to live in a state or district that allows or encourages the teaching of ID/Creationism, she or he will probably be told to teach the “strengths and weaknesses” of evolution. If one is going to teach the “strengths and weaknesses” of evolution, one should teach those of ID as well. Teachers can use this article to inform a discussion of the “strengths and weaknesses” of ID (or at least the weaknesses). Doing a point-by-point refutation of ID articles can be very tedious – though doing so with a single article, in a classroom as an exercise, may be a good idea – but this study gives teachers another option. When under pressure to present ID/Creationism in class, in the name of showing both sides of the “controversy,” it is important to establish that the controversy is a political and not a scientific one. This article, which shows the lack of scientific research behind many ID proponents’ claims, will be invaluable in these efforts.

Teachers in Other Fields

Teachers in non-science subjects may also find this article helpful. For instance, I have had several requests for materials from teachers and professors of writing. These instructors often need articles for their students to read and then write about. Having students read and write about the problems with Intelligent Design can educate them in several ways all at once.

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Guidelines for Authors & Photographers

The American Biology Teacher

Revised March 2014

We encourage our readers, biologists with teaching interests, and biology educators in general, to write for *The American Biology Teacher*. This peer-reviewed journal includes articles for teachers at every level with a focus on high school and post-secondary biology instruction.

The general categories of articles are:

Feature Article (up to 4000 words) are those of general interest to readers of *ABT*. Consider the following examples of content that falls into the feature article category:

- Research on teaching alternatives, including evaluation of a new method, cooperative learning, concept maps, learning contracts, investigative experiences, educational technology, simulations and games and biology standards
- Social and ethical implications of biology and how to teach such issues, genetic engineering, energy, pollution, agriculture, population, health care, nutrition, sexuality, and gender, and drugs
- Reviews and updates of recent advances in the life sciences in the form of an “Instant Update” that bring readers up-to-date in a specific area
- Imaginative views of the future of biology education and suggestions for coping with changes in schools, classrooms and students
- Other timely and relevant and interesting content like discussions of the role of the Next Generation Science Standards in biology teaching, considerations of the history of biology with implications for the classroom, considerations of the continuum of biology instruction from K-12 to post-secondary teaching environments, contributions that consider the likely/ideal future of science and biology instruction.

Research on Learning (up to 4000 words) includes reports of original research on innovative teaching strategies, learning methods, or curriculum comparisons. Studies should be based on sound research questions, hypotheses, discussion of an appropriate design and procedures, data and analysis, discussion on study limitations, and recommendations for improved learning.

Inquiry and Investigations (up to 3000 words) is the section of *ABT* that features discussion of innovative and engaging laboratory and field-based strategies. Strategies in this section should be original, focused at a particular grade/age level of student, with all necessary instructions, materials list, worksheets and assessment tools, practical, related to either a particular program such as AP and/or linked to standards like NGSS. The most appropriate contributions in this category are laboratory experiences that engage students in inquiry.

Tips, Tricks and Techniques (up to 1500 words but may be much shorter) replaces the How-To-Do-It and Quick Fix articles. This section features a range of suggestions useful for teachers including laboratory, field and classroom activities, motivational strategies to assist students in learning specific concept, modifications of traditional activities, new ways to prepare some aspect of laboratory instruction, etc.

Submission Guidelines

All manuscripts must be submitted online at <http://mc.manuscriptcentral.com/ucpress-abt>

- Authors will be asked to register the first time they enter the site. After receiving a password, authors can proceed to upload their manuscripts through a step-by-step process. Assistance is always available in the “Author Help” link found in the menu on the left side of the page. Additional assistance is available from the Managing Editor (managingeditor@nabt.org).
- Manuscripts must be submitted as Word or WordPerfect files.
- Format manuscripts for 8.5 × 11-inch paper, 12-point font, double-spaced throughout, including tables, figure legends, and references.
- Please place figures (including photos) and tables where they are first cited in the text along with appropriate labels. Make sure to include figure and table citations in the text as it is not always obvious where they should be placed. At the time of initial submission, figures, tables and images should be low resolution so that the final file size remains manageable.
- If your article is accepted, we will require that figures be submitted as individual figure files in higher resolution form. See below for file format and resolution requirements.
- NOTE:** Authors should be aware that color is rarely used within the journal so all artwork, figures, tables, etc. must be legible in black and white. If color is important to understanding your figures, please consider alternative ways of conveying the information.
- Authors are encouraged to submit multimedia files. Acceptable file formats include MP3, AVI, MOV, WMV, and FLV.

Editorial Procedures

- Communications will be directed to only the first author of multiple-authored articles.
- At least three individuals who have expertise in the respective content area will review each article.
- Although the editors attempt to make decisions on articles as soon as possible after receipt, this process can take six to eight months with the actual date of publication to follow. Authors will be emailed editorial decisions as soon as they are available.
- Accepted manuscripts will be forwarded to the Copy Editor for editing. This process may involve making changes in style and content. However, the author is ultimately responsible for scientific and technical accuracy. Page proofs will be sent to authors for final review before publication at which time, only minor changes can be made.

Writing and Style Guidelines

The *Chicago Manual of Style, 14th Edition* is to be used in regards to questions of punctuation, abbreviation, and style. List all references in alphabetical order on a separate page at the end of the manuscript. References must be complete and in *ABT* style. Please review a past issue for examples. Use first person and a friendly tone whenever appropriate. Use concise words to emphasize your point rather than capitalization, underlining, italics, or boldface. Use the SI (metric) system for all weights and measures.

NOTE: If all authors are not members of NABT, there will be page charges of \$100 per journal page to be paid before publication.

Guidelines for Preparing Figure Artwork

General requirements

- When your article is accepted, we will require that figures be submitted as individual figure files in higher resolution format. See below for file format and resolution requirements.
- **NOTE:** Authors should be aware that color is rarely used within the journal so all artwork, figures, tables, etc. must be legible in black and white. If color is important to understanding your figures, please consider alternative ways of conveying the information.

Halftone (photographic) figures

Digital files must meet the following guidelines:

- Minimum resolution of 300 DPI, though 600 DPI is preferred.
- Acceptable file formats are TIFF and JPEG.
- Set to one-column (3.5" wide) or two-column size (7" wide).
- If figure originates from a web site, please include the URL in the figure caption. Please note that screen captures of figures from a website are normally too low in resolution for use.

Line art figures

- Minimum resolution of 600 DPI, though 1200 DPI is preferred.
- Acceptable file formats are TIFF, BMP, and EPS.
- Set to one-column (3.5" wide) or two-column size (7" wide).

**If you have any questions, contact
Mark Penrose at managingeditor@nabt.org.**

Several times a year the *ABT* has issues that focus on a specific area of biology education. Future focus issues are published in most issues. The editors highly encourage potential authors to consider writing their manuscripts to align with the future focus topics.

Thank you for your interest in *The American Biology Teacher*. We look forward to seeing your manuscripts soon.

William McComas, Editor-in-Chief
ABTEditor@nabt.org

Mark Penrose, Managing Editor
managingeditor@nabt.org

Requirements for Submitting Cover Photographs for *The American Biology Teacher*

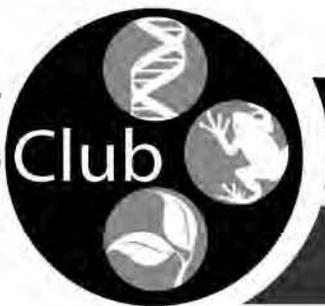
Submissions of cover photographs from NABT members are strongly encouraged. Covers are selected based on the quality of the image, originality, overall composition, and overall interest to life science educators. *ABT* has high standards for cover image requirements and it is important for potential photographers to understand that the size of the cover image generally precludes images taken with cell phones, point-and-shoot camera and even some older model digital SLR cameras.

Please follow the requirements listed below.

1. E-mail possible cover images for review to Assistant Editor, Kathleen Westrich at kmwestrich@yahoo.com.
2. Choose images with a vertical subject orientation and a good story to tell.
3. Avoid cropping the subject too tightly. It is best to provide an area of background around the subject.
4. Include a brief description of the image, details of the shot (i.e., circumstances, time of day, location, type of camera, camera settings, etc.), and biographical information in your e-mail message.
5. Include your name, home and e-mail address, and phone numbers where you can be reached.
6. Please ensure that the image meets the minimum standards for publication listed below and has not been edited or enhanced in any way. The digital file must meet the minimum resolution of 300 pixels per inch (PPI)—preferred is 400 PPI— and at a size of 8.5 x 11.25". We accept TIFF or JPEG images only.
7. For exceptional images, the editors will also accept sharp, clear, color 35 mm slides. Submit only the original; duplicates will not be accepted. Be sure to clearly label your slides with your name and contact information in ink. Contact Assistant Editor Kathy Westrich beforehand to discuss the possibility of submitting a 35mm slide or other non-digital format for consideration as an *ABT* cover.

NABT

BioClub



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The mission of the NABT BioClub is to recruit, support, nurture, and promote students who have an interest in biological sciences for personal reasons, academic preparation, the betterment of society, and possible career opportunities by providing guidance, resources, and activities to meet these goals.

Look for the BioClub logo to indicate recommended articles for NABT BioClub members. If you are interested in forming a chapter of the NABT BioClub, contact NABT at office@nabt.org.

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