

SCIENCE, SCIENTISM, AND THE ROLE OF THE SCIENCE TEACHER

(A Plea for Intellectual Honesty)

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AS SCIENCE TEACHERS, this program's graduates should have a deep understanding of science and its essential nature. Much of this is accomplished through the requirements of a physics degree that introduces teacher candidates to the findings of science and engages them in doing science. Still, knowing the products and processes of science is not sufficient for students to become effective science educators. Students must not only know and be able to do science, but they must also have a philosophical understanding of its nature.

I have learned through my own experiences of 40 plus years of science teaching that science teachers must try carefully not to inadvertently (or even overtly) foster a view called scientism. Scientism is the *belief* that the "hard sciences" like astronomy, chemistry, geology, and physics can provide all the knowledge necessary to obtain a complete grasp of reality. Scientific knowledge – obtained through empirical processes – is seen as vastly superior to any other forms of knowledge, such as those derived through philosophy, theology, and even divine revelation. In the view of strict scientism, these latter ways of knowing are considered subjective or anecdotal and consist of matter worthy only of private interpretation. This is so because they are not based on objective empirical evidence. Precluded from science is the belief in anything that cannot be experienced.

Many participants engaged in the public's irresolvable issues reject any arguments rooted in philosophy, theology, and religion. Swept away are arguments from natural law, teleology, ontology, religion, and other systems of logic. How often have we seen philosophical, ecclesial, and biblical teachings rejected out-of-hand because these are, supposedly, matters of only personal opinion? It is more common than you think.

This rejection usually takes a particular form, "We KNOW things through science; you merely BELIEVE because of reason or, worse yet, faith. What you BELIEVE is merely a matter of personal opinion. Your OPINION cannot supersede my KNOWLEDGE, which is based on objective evidence." In the world view of those who embrace scientism, scientific claims can be proven via experience, whereas claims based on other ways of knowing are not and cannot be proven. This view is tacitly espoused in universities, in the media, in the entertainment industry, in politics, in the courts, in personal face-to-face arguments, and many other places. This view most often has its most significant and most visible impact in the rulings of the U.S. Supreme Court.

Now, do not get me wrong. I know, understand, enjoy, and believe in the findings of "hard science." Science has served as the basis of my professional life for the past 40+ years. My concern about scientism is not based on being anti-science. Nothing could be farther from the truth. I bring it up here because scientism is one of several perversions of science that DOES matter. Allow me to explain.

Science can be described as both knowledge and the process of obtaining knowledge about the physical world. Science uses both observation and experimentation involving physical phenomena to make discoveries about the material world drawing conclusions based on evidence and right reason. Scientism marginalizes philosophy, religion, and other ways of knowing about the natural world.

While the view of scientism is rarely directly espoused in educational circles in my experience, it is there by implication. Science is often presented as the ONLY way of knowing, neglecting other ways of knowing with which science does not concern itself. As a result, students fail to see that a deeper understanding of the world can be had by going beyond what science and scientists tell us. This extension of science is no mere “random leap of faith.”

Science, being limited to phenomenal reality (the material world), cannot shed light, prove, or disprove the existence of numinal reality (the metaphysical world). Indeed, those who embrace science to the exclusion of other ways of knowing will not – indeed, must not – consider things outside of phenomenal reality. To these individuals, science becomes an obstacle to any non-physical truth that might undergird reality. Yes, scientists seek truth but will never discover it in its entirety if they out-of-hand preclude consideration of anything outside of the universe of observable phenomena. Consider, for instance, the concepts of God, evil, and sin.

For those who ensconce themselves in scientism, it is not difficult to reject God. They often reject God because they can't see God – and they can't prove either his existence or non-existence. But what about evil? Evil exists, and we know it, but we cannot see it with our physical eyes. English philosopher David Hume noted that when you see a murder, you see the physical actions, which are actual events taking place in specific locations and times. The gun, the knife, the rope – the weapon of choice – is an observable and quantifiable aspect. Still, the evil of murder is not physical. We do not see the evil of murder with our eyes because it is not a physical thing. No, we know the evil of murder (and other crimes) with a non-physical eye called conscience. It is through our consciences that we perceive evil. Only when the eyes of our consciences are warped, dimmed, closed, or forgotten can we deny the existence of evil. It is irrational to reject evil because we cannot see it. Evil has real physical consequences, such as pain, suffering, and death.

As “consumers” of science, we must be ever mindful that there are metaphysical matters that science cannot address and moral issues that science cannot resolve. Science, being restricted to the physical realm, cannot distinguish between right and wrong, good and evil, virtue and vice... It cannot tell us which of the following is the most important: the rights to life and liberty, the pursuit of happiness, privacy, and ownership. Neither can science tell us what right to privacy or right to material property actually means. It cannot tell us if corporations have political rights on par with humans. It cannot tell us if or why humans have a particular dignity above other living creatures and what this dignity implies. Those who embrace scientism do not – indeed, cannot – answer these questions based on only empirical evidence. These matters deal with non-material things, things that science does not address.

Those who embrace scientism – be they scientists or non-scientists – are limited in other ways, even as they relate to physical reality. They seem not to understand that scientists cannot see beyond the Big Bang to its cause, fathom the origin of life, and find the source of self-awareness. They cannot explain how inert matter gives rise to consciousness. They cannot explain the natural laws that appear to be written in the hearts of humans. They cannot explain from where a sense of guilt arises. They seem not to understand that life only comes from life, that something cannot come from nothing, and that inexplicable physical laws might manifest an unseen universal will.

No, the conclusions drawn by reasonable applications of faith are not scientific because, as such, they cannot be tested. That is a prerequisite for any scientific claim. For any claim to be scientific, it must be

falsifiable. This is so because science is naturally limited only to speaking about the natural world. Science cannot rule whether or not God exists; science cannot determine how many angels can dance on the head of a pin; science cannot prove that claims based on faith are neither reasonable nor unreasonable. Anyone who uncritically swallows statements of scientists concerning these matters is deluded.

Scientism matters! It matters because it calls for the rejection of explanations based on evidence and right reason from other ways of knowing worthy of consideration. Scientism has led many to dismiss out-of-hand belief in the spiritual world that evidence and right reason seem to suggest. At least in my experience, many who embrace scientism have sought refuge in deism, agnosticism, or atheism. This matters, too, because scientism has led to increasing hostility toward religious and other belief systems in all their forms.

Part 2: DON'T SCIENTISTS ALSO BELIEVE?

To assume that scientists deal only with knowledge and not beliefs is absurd. Scientists cling to many beliefs; they often call these beliefs assumptions or postulates to avoid appeals to authority. Still, in making such proclamations, they make themselves the authority. For instance, consider the following claims made by scientists:

- Nature is the same everywhere; all laws of science are universal and not merely local.
- The natural processes in operation today can explain physical events – past, present, and future.
- No physical effect exists without a natural cause.
- The universe is understandable and predictable, based on physical phenomena alone.
- Scientists do not accept any kind of claim or explanation for which no test is available or possible.
- When there are two or more possible explanations, the simpler is to be preferred.

So, yes, scientists also believe. They embrace and employ unobservable and untestable assumptions and postulates, which are themselves statements of faith.

The work of scientists that goes beyond mere reason is often most highly rewarded. These leaps of faith sometimes called “flashes of insight,” distinguish the collectors and recorders of scientific data from creators of so-called scientific knowledge. As British mathematician and historian Jacob Bronowski noted, scientists are not “cameras” merely set on recording information and gathering it into tables. Unless they go beyond what the data say and draw conclusions from the evidence, they are not true scientists. The statement, “The data suggest...” is the hallmark of the true scientist. Making sense of data is what science is all about. When one makes a “leap of faith” to conclude what the data suggests, one is doing science.

Part 3: PHYSICS AND ITS RELIANCE UPON FAITH

One good example of the existence of “scientific faith” is in the statement, “All copper conducts electrons.” How do we know this, or do we merely believe it? This conclusion is based on an inductive process, which is not a scientific process. Even if one tests 1,000 samples of copper to see if each conducts electricity, how does one know that the next one will not be the sample that does not lead to the same conclusion? One does not, and one cannot. A positive statement like the one in question can

never be proven, only disproven. Every sample of copper in the universe would have to be tested for the claim to be verified. Only one non-conducting sample of copper would be adequate to disprove the rule.

How do scientists know that “all copper conducts electricity” is a true statement consistent with reality? The fact of the matter is that they don’t; they merely believe. The conclusion is not valid based entirely on empirical evidence. Faith plays a significant role in the acceptance of the claim.

Now, consider a scientist studying the relationship of force, mass, and acceleration in a laboratory setting. Following a set of experiments that show acceleration is proportional to force and inversely proportional to mass, a graph is made of force versus the product of mass and acceleration. The graph best fits the linear relationship $F = k m a + b$. The slope, k , is found to be 1.0098, and the constant b is found to equal 0.0321 *newtons*. The conclusion based solely on evidence is that $F = 1.0098 \text{ times } m a + 0.0321 \text{ newtons}$. Now, this conclusion is absurd. For instance, if acceleration = 0, then *force must* = 0.0321 *Newtons*. The “real” scientist sees beyond the data – makes a leap of faith – and states $F = m a$, realizing that the difference between evidence and conclusion is due to errors in measurement.

The belief that $F = m a$ is a statement of faith that goes beyond what the evidence suggests. Still, this faith is not entirely unfounded. The statement $F = m a$ is a perfection that goes beyond pure reason. Indeed, as St. Augustine said, “Faith is the perfection of reason.” Unless we are willing to cross the threshold of pure reason, we will never come to a fuller understanding of the truth that only faith can provide.

Science is more than merely an attempt to develop general principles and specific laws based on empirical evidence. It is also an effort to explain certain relationships existing in experimental evidence. As such, science, too, is geared toward the abductive processes of hypothesis and theory development. These practices include good doses of evidence, rational thought, and creativity. They go far beyond principle and law development to come up with hypothetical explanations and experimental tests.

An experience that lucky undergraduate physics majors have is conducting hypothesis development to determine the buoyant force’s origins. While the hypothesis that the difference in forces between the top and bottom surfaces of an immersed object does not admit other assumptions such as “and then a miracle occurs,” the hypothesis can readily be tested and indeed proven within the limits of measurement. This is not always so with physics. Consider, for instance, questions about the nature of the Standard Model of the atom, the origin of the universe with a cosmic Big Bang, the existence of dark energy and dark matter.

Through the use of powerful colliders such as those at Fermilab and CERN, physicists believe that the nucleus consists of subatomic particles that, by the standard model, themselves consist of different combinations of numbers and types of quarks. No one has ever seen a quark or isolated a quark. They are only hypothesized to exist – and then only in groups of two or three under the universe’s current conditions. The reason that scientists accept the standard model of the nucleus is because it works. It both explains and predicts accurately. Still, that is no guarantee that it is true. It is just the current best explanation – just like other models of the atom before it: the plum pudding model, the Bohr model, the quantum model, and so forth. Scientists believe in something that they cannot see, only deduce from the evidence.

The concept of the Big Bang originated from observational evidence gathered by American Astronomer Edwin Hubble. He showed that galaxies with increasing distance also had increasing recessional speeds. With the assistance of Belgian priest and scientist Abbe Georges Lemaître, Hubble came up with the idea that the universe originated from a cosmic explosion. No one was around to observe this so-called Big Bang, but there is plenty of other evidence to support it and nearly every scientist today believes in it.

Though they cannot account for it, the recently detected increasing rate of expansion of the cosmos initiated with a Big Bang some 13.8 billion years ago, astronomers are now claiming the existence of dark energy. The increasing rate of expansion – contrary to everything our knowledge about gravity suggests – indicates the presence of this mysterious dark energy – a mysterious force not unlike gravity but one that is repulsive and grows with increasing distance. Again, belief in the existence of dark energy is seen as a logical extension of what empirical evidence suggests.

Though astronomers cannot see dark matter despite repeated attempts at detecting it, they believe firmly in its existence. Rotation curves of galaxies show beyond any reasonable doubt that most of a galaxy's mass exists beyond its visible disk of stars. This belief in something that cannot be seen or directly detected – merely deduced from existing evidence – is considered by scientists to be a logical extension of what empirical evidence suggests.

It is interesting to note from these examples that scientists are doing the same thing that some claim others who have other belief systems should not do – believing in things for which there is no direct empirical evidence. When religious believers point to God's existence as an explanation for the origin of the universe, of life, consciousness, free will, guilt, and so much more, are they doing anything different from what scientists themselves are doing? In ordinary human experience, we have never seen an effect without a cause. We cannot explain how life originated from non-living material. We cannot explain how complex combinations of elements produce consciousness and emotions like love and hate. How is it that we are more than the sum of our parts? What is the cause of these things? These questions cannot be answered, perhaps, unless we have recourse to an uncaused cause.

May not religious believers use right reason to draw conclusions suggested by the evidence just as scientists do? Is not religious belief in an uncaused cause just as legitimate as a belief about the origin of the universe, the existence of dark energy and dark matter, and so forth? Are scientists guilty of a double standard? Do scientists hold non-scientists to standards that they do not uphold? These are questions worthy of detailed consideration and discussion.

Part 4: MATHEMATICIANS HAVE FAITH TOO!

Do all scientists and those with a considerable science background embrace science as the only way of knowing? No, that is hardly the case. There is sufficient evidence that other ways of knowing exist, bear fruit, and are acceptable to those who embrace science. For instance, mathematicians, politicians, and historians have ways of knowing that do not rely on scientific methods per se. Nonetheless, their findings are embraced by the scientific world. Why is this not so for other ways of knowing, such as philosophy, theology, and religion? Don't they demonstrate faith too?

Just like physicists, mathematicians have faith. Consider, for instance, their belief in an infinity of integers – whole numbers – without ever seeing or experiencing an infinity of numbers. How do they

“know” that infinity exists? They do not. They merely believe. By using rational thought, they conclude that whole numbers exist without limit. The reason that if one states a number, ostensibly the largest number, then one can be added to that number, and a larger number than the prior largest number exists. Therefore, the number of integers exists without limit.

By reason, they also believe in the following conclusion:

A is greater than B.
B is greater than C.
Therefore, A is greater than C.

Mathematicians logically conclude through this modus ponens syllogism that A is greater than C without actually having experienced it. Rational thought leads to this conclusion – a belief. Belief is not knowledge, but belief can be well-grounded in experience and right reason. Again, the faith of mathematicians is an extension of knowledge – the so-called perfection of reason.

Mathematicians do not typically conduct observations or experiment with things of the material world, yet their conclusions are seen as valid. Their methods cannot be considered scientific in the strictest sense of the word. Instead, mathematicians make assumptions and then use logic to make conclusions based on reason. Consider, for instance, the five postulates of Euclid’s geometry that are accepted without proof. These postulates are accepted merely based on their “self-evident” nature, even though they have never been proven.

1. A straight-line segment may be drawn from any given point to any other.
2. A straight line may be extended to any finite length.
3. A circle may be described with any given point as its center and any distance as its radius.
4. All right angles are congruent.
5. If a straight line intersects two other straight lines and so makes the two interior angles on one side of it together less than two right angles, then the other straight lines will meet at a point if extended far enough on the side on which the angles are less than two right angles.

Despite the claim to do otherwise, rationalists (and even experimentalists) say they possess knowledge of things that cannot be seen and cannot be directly experienced. Like religious believers, mathematicians too have faith – beliefs based on something other than direct experience.

Part 5: POLITICIANS AND FAITH

Politics can be seen as yet another way of knowing. Politics can be thought of as a way to deal with decision-making, management of power relationships involving individuals and groups, and control and distribution of valued resources. A study of human interactions, relationships, motivations, fears, values, philosophies, and the like can lead people through reason (right or otherwise) to certain conclusions. While rightly or wrongly, attributing certain traits or motivations to individuals and situations and following them to their logical ends allows politicians to draw certain conclusions. No matter how suspect the assumptions, politics is still widely accepted as a means of achieving governance in whatever its form.

Part 6: HISTORIANS AND FAITH

Historians will sleuth events of the past by talking to or reviewing records of first-hand witnesses, visiting historic sites, examining pertinent material objects, considering human motivations, examining photographs, reflecting on secondary sources, and so forth. They use evidence and right reason to draw conclusions, not unlike scientists. As such, history as a way of knowing acceptable to those who can and do embrace science.

Part 7: OTHER WAYS OF KNOWING

There are many other ways of knowing, such as language, sense perception, emotion, philosophy, and even intuition. So, science, mathematics, politics, and history, and many other ways of knowing are accepted by those who embrace science and scientism while, at the same time, rejecting certain other ways of knowing such as religious faith, morality, divine revelation, theology, the study of natural law and so forth. That this is so is not in doubt. The situation is much like those who might say, "There are only five senses: sight, smell, hearing, taste, and touch." Those who would make such a naïve claim have a very limited understanding of perception. How can we sense anger, hunger, thirst, balance, self-awareness, friendship, and love, for instance, unless we have more than just the five traditional senses? Are scientists any different when they reject these latter ways of knowing?

Part 8: WHY DO CATS HAVE TAILS?

Scientism arises in part from the fact that humans are proud, and scientists are no exception. Scientists take pride in their work and justifiably so. Today's modern world is a technological marvel. Think about all the time, labor-saving, and entertainment devices with which we surround ourselves. Think of the myriad of toys, computers, TVs, microwaves, social networks, and so much more that we enjoy and use to inform ourselves. Think of the advances of the life sciences, earth science, astronomy, chemistry, physics, medicine... All the innovations that make life pleasant, enjoyable, and even fun have mostly been brought about by science findings. Scientists, engineers, and technologists are justifiably proud. Still, this pride must be tempered by reason when it comes to an understanding of the nature of reality. Moreover, while science and its products are indeed amazing, the pride with which scientists view their knowledge of the world is neither without limit nor wholly justified.

This bewitchment of pride is manifest in two specific ways, dogmatism and skepticism. Under the spell of dogmatism, scientists who embrace scientism believe that science has all the answers, or will eventually come up with them given adequate time. Under the spell of skepticism, scientists who embrace scientism think that other ways of knowing have no meaningful answers and that any answers provided are matters of mere personal opinion.

While scientists seek the truth, they should not presume to possess it even when a particular phenomenon is well understood. It was once believed that Newton explained all motion, then along came Einstein and his theories of special and general relativity. It was once thought that the world was deterministic, that if we knew the location and state of motion of every particle in the universe, we could predict the future. This deterministic worldview has been replaced by a probabilistic worldview based on the uncertainty of statistics and quantum mechanics.

More simply, consider a physicist's knowledge about the flight of a projectile – something that scientists understand well but not entirely. If given initial conditions such as position, velocity, acceleration due to gravity, launch angle, wind resistance and direction, the motion of the earth, and so forth, a scientist can tell us about the projectile's position, velocity, and acceleration at points of time in the future. Also, if someone wants to launch a projectile like a rocket halfway across the planet, they can do so with uncanny accuracy!

While it is true that the scientist's knowledge about projectiles is indeed profound, scientists still cannot explain why gravity – which plays a significant role in the flight of projectiles – works the way it does. But does knowing the name of something like gravity, or even its magnitude and direction at a particular location, mean that we truly understand what it is and why it operates? Of course not. To say that something falls due to gravity when released merely notes that it accelerates downward but does not explain why it does so. As American physicist and Nobel laureate Richard Feynman noted, we should not confuse knowing the name of something with having any knowledge about it.

This is much like the situation with a stalled car. A car is moving along a highway and then, without warning, slows to a halt, much to the driver's surprise. The engine has quit running. While one might know all about thermodynamics, the need for fuel, gas and air mixture, compression, spark plugs, ignition, the stroke of the piston, the role of the piston rod, the turning of the crankshaft, and the transfer of mechanical motion through the transmission to the driveshaft and from there to the wheels, this does not mean that the scientist can identify that the real reason behind the car stopping is that the driver failed to put gasoline into the tank! The reason or reasons – motivation, effort, knowledge – are not physical observables. Therefore the scientist who restricts himself or herself to dealing with physical reality simply does not necessarily have a clue about fundamental reasons that are part and parcel of an accurate and complete understanding of the nature of the situation.

While a scientist might know that cats have tails, that the tails are long and thin, filled with bones, muscles, tendons, and nerves, are covered with skin and hair, and can be moved in any way that a cat so chooses, this does not mean that scientists know why cats have tails.

Part 9: IS THERE GOOD IN SCIENTISM?

While some might argue that there is good in scientism, I beg to differ. Some say what the good is in scientism is a healthy skepticism. Skepticism is, without a doubt, a good habit of mind for scientists and all others. Indeed, we all should be skeptical of any claim for which there is no evidence or right reason to substantiate it. Unfortunately, what some see as skepticism in scientism is actually bias – bias against any belief that does not fit within a preconceived notion that nothing exists outside of the observable. Those who see this good in scientism believe only in phenomenological reality while precluding numinal reality.

The reason that one who embraces scientism rejects the existence of a supreme being, for instance, is because that person rejects any belief in a supreme being *a priori*, rejecting such a belief out-of-hand regardless of any evidence or right reason that might support belief in it. This is out-and-out bias. Rejecting an evidence-based and well-reasoned belief in something by stating in effect, "Don't confuse me with evidence and reason," is an approach from which no good can come. Intellectual honesty and objectivity are two healthy habits of mind that are sacrificed when one embraces scientism.

How then is a critically thinking individual to embrace a scientific world view without rejecting the healthy habits of mind that good scientists embrace, and without dismissing out of hand things that might exist beyond the physical real dealt with by scientists that those who embrace scientism do? Let's take a cue from the Greek philosopher Aristotle. Paraphrasing Aristotle in *Nicomachean Ethics*, virtue lay in the middle way. Virtue exists between the extremes of deficit and excess of a given trait. For instance, a generous person is between the extremes of the miser and the spendthrift.

A centrist position is a better position for those who are intellectually honest, even if they don't accept a numinal reality. Those who accept a phenomenal reality, along with accepting the possibility of a numinal reality, tend toward the more virtuous and sustainable intellectual position, and I call for this open-mindedness. As I see it, there are three positions one can embrace in this question of the nature of reality:

- 1) embrace phenomenal reality and entirely reject numinal reality based on empiricism,
- 2) embrace phenomenal reality and at least admit the possibility of numinal reality, and
- 3) embrace without restraint both phenomenal and numinal realities.

As someone with a considerable science background and teaching experience, I posit that positions 1 and 3 are indefensible. The first is grounded in bias; the third is not based on direct observation but on the perfection of reason, which is not readily testable. In both cases, one may choose to believe what one will, but neither has a claim on scientific certainty. The only sensible and intellectually honest way of solving this dilemma is to admit the possibility of a numinal reality without demanding emphatic proof in the physical realm.

Part 10: THE NATURE OF THE SCIENTIFIC ENDEAVOR

Scientists legitimately refuse to admit as an explanation for any physical principle, law, or theory a supreme being, and this is legitimately so.

The philosophical prohibition of a god or gods into the scientific milieu does not necessarily mean that science or scientists reject the existence of a supreme being. Not at all. There are many scientists who are or who have been believers in a supreme being. The list of such scientists is both long and prestigious.

It is interesting to examine why certain other ways of knowing are rejected by those who embrace science and scientism. What do the following ways of knowing – religious faith, morality, divine revelation, theology, and the study of natural law – have in common? One unifying aspect is a belief in a supreme being or universal lawgiver. Is it possible, therefore, that because scientists refuse to admit a supreme being as a possible explanation of phenomenal reality that they are pre-disposed to reject anything that might suggest a “Deus ex Machina” solution? This is the situation at best; at worst, one has to consider bias and the outright rejection of a belief in a supreme being as a source of denial that religious faith, morality, divine revelation, theology, and the study of natural law are legitimate ways of knowing in addition to methods currently accepted no matter how flawed.

Part 11: KNOWLEDGE, REASON, AND FAITH

Science is, in the main, is descriptive and not explanatory. Science tends to describe the physical aspects of nature; it can – but generally does not – explain the reason for nature acting the way it does.

There is much that scientists do not know. They know the name for gravity and can even express the law of gravity, $F = G \frac{m_1 m_2}{r^2}$, but they do not understand why or how it operates. This so-called “spooky action at a distance” (as Einstein called it), which is not a contact force, simply does not at the current time have an adequate explanation. The same can also be said for the other fundamental forces of nature – electromagnetic, nuclear strong and weak forces, and possibly dark energy.

There are plenty of other mysteries of science. What role does the fine-tuning constant play in nature? If the value of this constant was off by even an exceedingly small amount, the universe as we know it could not exist. From whence came the universe, life, consciousness? These are all questions begging for an answer, and scientists are nowhere close to providing an explanation. Perhaps they never will. Am I saying that scientists should all jump aboard the bandwagon, saying, “God did it, or God wants it so or that laws are the manifestation of a supreme being’s will?” No, but I AM saying that scientists and science teachers should be ready and willing to admit the limitations of science and cast off any unwarranted belief in scientism.

Given these facts, it should be evident that scientific knowledge is limited, and its search for the whole truth destined to fail if it does not admit as possible sources of knowledge derived from other ways of knowing. Knowledge – in my mind’s eye – is inextricably linked to both reason and faith.

Pope John Paul II (Karol Wojtyła) said it beautifully in his 1998 encyclical letter *Fides et Ratio: On the Relationship Between Faith and Reason*.

“Faith and reason are like two wings on which the human spirit rises to the contemplation of truth; and God has placed in the human heart a desire to know the truth - in a word, to know himself - so that, by knowing and loving God, men and women may also come to the fullness of truth about themselves.”

Science and faith are like two sides of the same coin. Both have as their goal the solution of mysteries in the pursuit of truth. They have a tremendous amount in common. Both have as their goal the understanding of reality. Both use evidence and right reason to draw conclusions about things seen and unseen. Both seek to improve the human condition. The biggest difference is that science deals with physical truth; religion deals with metaphysical truth. Science alone is inadequate. Faith alone is inadequate. Only by examining the world's mysteries from both sides of the coin can we hope to gain a fuller understanding of its reality.

The proper relationship between science and faith can be characterized as a conversation, each providing insights, and valuable services to the other. This relationship was epitomized in a letter sent from Pope John Paul II to then director of the Vatican Observatory, Reverend George Coyne, on June 1, 1988. In his letter, the pope stated,

“Science can purify religion from error and superstition; religion can purify science from idolatry and false absolutes. Each can draw the other into a wider world, a world in which both can flourish.”

Because faith and reason are both rooted in the truth of reality, they should not contradict. As Pope John Paul II said in his 1996 talk to the Pontifical Academy of Science,

“Truth cannot contradict truth.”

To the extent that they appear to conflict is the same extent to which our knowledge is incomplete.

Part 12: THE ROLE OF THE SCIENCE TEACHER

So, what are we as science teachers to make of all these concerns and comments about scientism? In my personal opinion, there are several values which we as science teachers should hold and several obligations for which we should be responsible.

Recall that scientism is the *belief* that the “hard sciences” like astronomy, chemistry, geology, and physics can provide all the knowledge necessary to obtain a complete grasp of reality – all that is, was, and ever will be. As has been seen, this is a demonstrably false belief. We must keep this in mind as we teach science.

Admittedly, it is not the role of the science teacher to teach religion. Far be it from us to do so in a course dedicated to science. Still, this knowledge of scientism should temper our enthusiasm for promoting science – either overtly or inadvertently – as the be-all, end-all of human understanding about the nature of reality. It is the only intellectually honest thing to do. Intellectual honesty obliges us to teach science in the light of all that we know.

I believe that four actions are appropriate for us as teachers of science:

- 1) We need to know that scientism exists, be fully aware of what it is, and recognize that it manifests in many different ways.
- 2) We need to understand that the way we teach science can alter student views related to not only science but to faith as well.
- 3) We need to help students understand that science has limits and cannot answer all questions about the world.
- 4) We need to help students understand that science is not the only way of knowing.

Again, as science teachers, it is not our obligation to teach faith. However, we should feel compelled not to attack faith as a legitimate way of knowing through scientism's insidious intentional promotion. In my opinion, we are obliged from doing so as a matter of intellectual honesty.

As science teachers, we should be ever mindful that the full truth of reality is like sunlight. Those who espouse scientism are like owls or bats. They can perceive the fireflies of night but are blinded by the light of day. This being the case, they do not and cannot embrace the fullness of truth – both natural and supernatural – which is reality itself.