

BRIDGING SCIENCE AND FAITH: EDUCATIONAL STRATEGIES FOR TEACHING EVOLUTION WITHOUT CONFLICT

CONSTRUINDO PONTES ENTRE CIÊNCIA E FÉ: ESTRATÉGIAS EDUCACIONAIS PARA O ENSINO DA EVOLUÇÃO SEM CONFLITO

TENDIENDO PUENTES ENTRE CIENCIA Y FE: ESTRATEGIAS EDUCATIVAS PARA LA ENSEÑANZA DE LA EVOLUCIÓN SIN CONFLICTO

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ABSTRACT

The teaching of biological evolution has historically faced challenges due to tensions between science and religion, often leading to the perception of a false dilemma between the two. This article explores pedagogical strategies aimed at promoting the acceptance of evolutionary theory without necessitating the rejection of religious faith. By adopting an approach that respects different cultural and theological perspectives, the study seeks to reduce cognitive dissonance among students with strong religious convictions. Through a qualitative analysis of student cases, effective methodologies are identified to address evolution without direct confrontation with religious beliefs, focusing on three key aspects: the origin of the universe, the origin of life, and the emergence of consciousness. The discussion explores how these topics can be pedagogically framed to foster critical thinking and dialogue while avoiding the false dichotomy between belief and scientific knowledge. Furthermore, the article highlights the importance of culturally competent teacher training and educational approaches that move beyond polarized narratives. The conclusion emphasizes that educational mediation based on understanding and mutual respect can create a more inclusive learning environment where science and faith coexist without compromising the integrity of scientific education.

Keywords: Evolution education; science and religion; pedagogical strategies; acceptance of evolution; science education.

RESUMO

O ensino da evolução biológica tem sido historicamente desafiado por tensões entre ciência e religião, frequentemente resultando na percepção de um falso dilema entre ambas. Este artigo investiga estratégias pedagógicas voltadas para a promoção da aceitação da teoria evolutiva sem que isso implique a rejeição da fé religiosa. Ao adotar uma abordagem que respeita diferentes perspectivas culturais e teológicas, busca-se reduzir a dissonância cognitiva entre alunos com fortes convicções religiosas. A partir da análise qualitativa de casos de estudantes, identificam-se metodologias eficazes para abordar a evolução sem confronto direto com a crença religiosa, considerando três pontos centrais: a origem do universo, a origem da vida e o surgimento da consciência. Discute-se como esses temas podem ser explorados pedagogicamente para estimular o pensamento crítico e o diálogo, evitando a dicotomia entre crença e conhecimento científico. Além disso, o artigo destaca a importância de uma formação docente culturalmente sensível e de abordagens educacionais que transcendam discursos polarizados. Conclui-se que uma mediação educacional baseada na compreensão e no respeito mútuo pode criar um ambiente de aprendizado mais inclusivo, onde ciência e fé coexistem sem prejuízo para a integridade do ensino científico.

Palavras-chave: Ensino de evolução; ciência e religião; estratégias pedagógicas; aceitação da evolução; educação científica.

RESUMEN

La enseñanza de la evolución biológica ha enfrentado históricamente desafíos debido a las tensiones entre la ciencia y la religión, lo que a menudo genera la percepción de un falso dilema entre ambas. Este artículo analiza estrategias pedagógicas dirigidas a promover la aceptación de la teoría evolutiva sin que ello implique la negación de la fe religiosa. Adoptando un enfoque que respeta diversas perspectivas culturales y teológicas, el estudio busca reducir la disonancia cognitiva en estudiantes con fuertes convicciones religiosas. A partir de un análisis cualitativo de casos estudiantiles, se identifican metodologías eficaces para abordar la evolución sin generar confrontaciones directas con las creencias religiosas, centrándose en tres aspectos clave: el origen del universo, el origen de la vida y el surgimiento de la conciencia. Se examina cómo estos temas pueden enmarcarse pedagógicamente para fomentar el pensamiento crítico y el diálogo, evitando la falsa dicotomía entre creencia y conocimiento científico. Además, el artículo subraya la importancia de la formación docente con competencia cultural y de enfoques educativos que trasciendan los discursos polarizados. Se concluye que una mediación educativa basada en la comprensión y el respeto mutuo puede generar un entorno de aprendizaje más inclusivo, donde la ciencia y la fe coexistan sin comprometer la integridad de la educación científica.

Palabras clave: Enseñanza de la evolución; ciencia y religión; estrategias pedagógicas; aceptación de la evolución; educación científica.

INTRODUCTION

Historically, the relationship between science and religion has been characterized by periods of conflict, dialogue, and integration (Barbour, 1990; Gould, Shale, 1994). While some models propose a strict separation between these domains (nonoverlapping magisteria) (Gould, 1997), others suggest a complementary perspective that allows for dialogue without compromising scientific integrity (Lamoureux, 2009). However, contemporary discussions on evolution education emphasize that science and religion do not operate in isolation from broader socio-cultural dynamics (Ecklund, Scheitle, 2017). The resistance to evolutionary theory varies across societies due to a combination of religious, political, and educational factors (Plutzer, Branch, Reid, 2020; Silva, 2025). Thus, an analysis of pedagogical strategies must consider these contextual influences to create effective educational interventions. This article seeks to explore whether such a dialogue can be effectively fostered in classrooms discussing evolutionary theory (Barbour, 2002). To illustrate the applicability of this dialogue, it is essential to present concrete educational cases where the interaction between science and religion was tested in real classroom settings. Providing detailed contexts and student backgrounds can strengthen the relevance of the theoretical framework by anchoring it in actual educational experiences.

To better contextualize the dialogue between religion and science, it is essential to highlight that religious leaders from different periods of the Catholic Church have acknowledged the compatibility between the theory of evolution and Christian faith. Pope John Paul II, in his *Message on Evolution to the Pontifical Academy of Sciences* (1996), reaffirmed that biological evolution is “more than a hypothesis,” representing a widely accepted theory within the scientific community. Pope Benedict XVI, in turn, addressed the three fundamental mysteries, the origin of the universe, life, and consciousness, emphasizing that these questions can coexist within both scientific and theological frameworks. More recently, in 2014, Pope Francis reiterated that God “is not a magician with a magic wand” but rather created human beings through a natural process, including evolution. These positions indicate that the strategies proposed in this article are not novel but rather part of a longstanding tradition of dialogue between science and religion.

One of the great educational challenges in the world is the teaching of Darwinian evolution, one of the scientific pillars of the biological sciences that is fundamental to science and biology (Dobzhansky, 1973), integrating and explaining a wide range of areas. While on the one hand there is almost unanimous acceptance and recognition in the academic world of the value of evolutionary theory, levels of rejection seem to increase and consolidate in various parts of the world. Countries such as Denmark, the United Kingdom and Sweden have high levels of acceptance of the Darwinian theory; on the other hand, Turkey, United States and Poland, have very low levels, despite often having a relatively higher education in their population (Miller, Scott, Okamoto, 2006). However, recent longitudinal studies demonstrate shifts in public acceptance of evolution in countries like the United States, which highlights the dynamic nature of this issue and its relevance for global education (Baker *et al.*, 2022; Heddy, Nadelson, 2013).

Recent studies indicate a growing acceptance of evolution in certain regions, despite persistent resistance in others (Dunk *et al.*, 2019; Miller *et al.*, 2022). These trends highlight the importance of continuous educational interventions that address misconceptions and cultural barriers.

What do countries with high rates of rejection of the theory of evolution have in common to generate such a phenomenon? Perhaps several factors, but certainly all of them have deeply religious foundations, with faith as a central feature of their societies. This should not be expected to automatically be used to deny or accept evolutionary theory, or to acknowledge evolutionary theory and its value for scientific advancement. Still, it has often been constituted as such an obstacle, often insurmountably, creating an irreconcilable conflict between science and religion. This has had a dire impact on education (Mahner, Bunge, 1996).

The mechanism that often leads to this conflict is the idea that it is necessary to choose between being an evolutionist or being religious, placing at a crossroads those who are deeply believing and wishing to walk a path in science or to enjoy seeking such knowledge. It is also important to recognize diversity within religious traditions. For example, Christian denominations vary significantly in their interpretations of liturgy, morality, and the role of God in the universe, which directly impacts how individuals reconcile their faith with scientific concepts (Chardin, 2002; Ratzinger, 2009). This need for such an ultimatum is closely linked to two very active positions in society. One is that of

radical atheists, a group that is still relatively small, but very noisy in the media and academics, which publishes books with large numbers of readers. For them, there is no way out; religion comes from ignorance and provides no meaning. Enlightenment, advancement, and explanation can only come from science. Believing in God disqualifies anyone from rational, enlightened thought (Dawkins, 2016). The big problem with this approach is that most of the population believes in God. Should that portion be deprived of scientific knowledge? Or is this position possibly only intended to “convert” non-believers to activist atheism? On the other side of this impasse, we have significant percentages of the population of several countries denying that evolution has occurred at all.

On this side of the controversy, certain religious movements claim that believing in evolution is incompatible with belief in a Creator. This claim is made to foster a clash between science and religion, especially regarding biological evolution and its teaching. Pastors, leaders of various religions, and even some academics claim that the teaching of the Darwinian theory is unscientific and is conceived as a strategy against religion. They point out that there is a plot against religious beliefs, against belief in a God, and that scientists are a priori atheists and use education to spread this supposed ideology. Like radical atheists, they see no other way to address the subject of evolution except through conflict. They argue it is necessary to take sides and to choose which side a person is on (Barbour, 1990). As a result, this large and influential group inspires a large segment of society to affirm that it is only possible to believe in either God or that evolution has happened.

To complicate this already confusing and conflicting landscape, a new group, or movement, presents a supposed conciliation through “intelligent design”. This emerging strategy is gaining strength in many countries, proclaiming that they have made the greatest discovery in the history of science or humanity. They try to demonstrate that they have found the solution, for they have “discovered” that biological evolution has occurred, but it has been conducted, brilliantly and perfectly, by the hands of a Creator, therefore by design, even though they assert that this solution does not imply the existence of a specific “God”. They claim to “prove” that the evidence of this intelligent Engineer is apparent within the history of life on Earth and is therefore a possible solution to the complexity of life and biodiversity. They encounter a great misunderstanding, however, by denying all the proven assumptions, now proven by an unlimited number of lines of evidence and entire areas of science. For them, there is no random mutation or natural selection in macroevolution, nor is macroevolution happening or has happened. They follow the same primer as the radical religious creationists, saying that evolutionary scientists are “lying” about the evidence for evolution and that there is a plot against their movement. Once again, this antagonism drives away those who could benefit from scientific knowledge. Worse, this group has falsely claimed that their “science” offers a conciliatory discourse of accommodation between science and religion (Silva, 2017). This has led to them being relatively successful in the dissemination of their ideas, even if, for this triumph, it must distort scientific data, as it has done with the myth of Noah’s Ark, mixing the knowledge of science and faith in a mixture that falsifies (Silva, 2020).

It is important to mention that, regardless of which side of this ideological wall one exists on, biological evolution is a fact of nature, absolutely proven by many lines of evidence (Gould, 1981). In this way, the theory is fundamental for the teaching of biology and life sciences and provides an excellent example of how scientific advancement takes place. Therefore, it is imperative to find ways to avoid the conflict between evolutionary science and religion, and to find ways to avoid barriers to scientific understanding and to demonstrate the importance of scientific explanation (Coyne, 2010).

Many authors have sought this path of conciliation, with varying degrees of success. Some propose that evolution is a gift to religion, since it would seem to explain the evils of the world, including suffering and imperfection (Ayala, 2007). Others have developed religious movements that seek the integration of both sides, without denying the assumptions of evolutionary theory (Collins, 2003). Darwin himself did not perceive incompatibility between his theory and the possibility of being fervently religious.¹ But these approaches, while valid, have not reached classrooms around the world, and finding more tenable alternative solutions is very important.

¹ *It seems to me absurd to doubt that a man may be an ardent Theist & an evolutionist.* Darwin Correspondence Project, “Letter no. 12041,” Available at: <http://www.darwinproject.ac.uk/DCP-LETT-12041> Accessed on: 22 September 2018.

One of the proposals to alleviate this conflict has been to categorize individuals in relation to their position regarding evolution (or science) and religion. Some propose a scale of closeness and withdrawal from one of the fields, which could begin with those more dogmatic in relation to religion, those who believe that the earth is flat on one side, and on the opposite spectrum those expounding the radicalism of certain evolutionist materialists (Scott, 1999). Others suggest that a framework presenting the characteristics that define one's level of commitment to science and religion, in relation to the subject of biological evolution, thus allowing individuals to find their place (Lamoureux, 2009). However, it is challenging to incorporate a level of sophistication into the analysis for positioning oneself within this spectrum regarding the question of science and religion in classroom practice for teachers and students.

We need to find ways or strategies, to deal with the various issues that permeate the religious and scientific fields; we need to deal with unnecessary and counterproductive conflicts even on issues that should be peaceful, such as environmental protection. However, even in these aspects that should be of interest to everyone, there are divergent views that are often based on dogmatic perceptions that do not accept conciliation (Silva, 2023a).

It is essential to reflect that most teachers and students in different countries, such as Brazil and the United States for instance, are religious individuals, raised in religious societies, who see religion as a strong factor influencing their lives (Miller, Scott, Okamoto, 2006). In this context, we must convince them of the value of science and how everyone can and should benefit from it without denying their religious beliefs. However, religion may not always be the primary determinant of acceptance of evolution (Wingert *et al.*, 2023). Socioeconomic and cultural factors also play a significant role, indicating the need for a more comprehensive approach to addressing these barriers (Lopreato, 2024). In these countries, there is a silent conflict in the classroom between religious groups and the acceptance or denial of evolutionary theory.

These challenges are not exclusive to the contexts analyzed in this study but reflect broader patterns observed in Latin America. A comparative analysis of biology teachers in Argentina, Brazil, and Uruguay found significant differences in how educators reconcile evolution with their religious beliefs. While Argentine and Uruguayan teachers, despite being mostly religious, do not consider God relevant to evolution, many Brazilian teachers attempt to integrate religious perspectives into their understanding of evolutionary theory, believing that God plays a role in the evolutionary process (Silva, 2024). These findings reinforce the argument that religious and cultural factors shape the acceptance of evolution in educational settings, highlighting the need for pedagogical strategies that foster dialogue rather than confrontation (Silva, 2023b).

The relationship between Church and Science, built historically, had very difficult moments, with antagonism between the two fields, but it is necessary to note that it is possible to follow different beliefs (Christian, Muslim, Jewish), ultimately to believe in God, and at the same time understand that evolution occurred (Carvalho, Clément, 2007). However, some fundamentalist religious groups claim that it is impossible to be an evolutionist and religious, and that it is necessary for schools to assume creationism, or its supposedly scientific version, "intelligent design", something perceived among some representatives of the current Brazilian government (Lodi Ribeiro, 2019). This issue also affects North American high schools, appealing to the general population of that country, with a large number of followers of creationism and intelligent design, including among science and biology teachers, pointing out an important dimension of this discussion (Berkman, Pacheco, Plutzer, 2008).

There is currently a new religious distribution in the Brazilian population. According to data from CENSO 2010, there is an increasing number of evangelicals and a decline in the number of Catholics; many of these evangelicals belong to congregations that have a literal biblical interpretation, generating difficulties in acceptance and assimilation of Darwinian theory (Silva, Mortimer, 2014). Therefore, the issue of the growth of evangelicals in Brazil is related to the increase in the spread of creationist ideas, even if this phenomenon is not exclusive to this religious segment, as many would be interpreting the Bible "word by word", especially in relation to the Old Testament (Bizzo, 2013; Martins, 2013). It was also detected that among evangelicals, there is a strong defense of Young Earth Creationism (a more dogmatic form of creationism) and intelligent design, data confirmed by the Datafolha institute in 2010, which pointed out that one in four Brazilians believes in Young Earth Creationism. More than half believe in intelligent design, so

they would accept evolution if it were guided by God. It is worrying to think that this pseudoscience (intelligent design) finds a place in educational and academic spaces, which should be dominated by evidence-based science (Silva, 2023). The recent growth of those who call themselves non-religious was also detected among Brazilians, including atheists, agnostics, and those who believe in God but would not follow any specific religion (Silva, Mortimer, 2014).

This new religious spectrum poses a new challenge to Brazilian education and to the teaching of biological evolution, urgently needing the mediation of the teacher in the struggle. How can the teacher deal with two growing and antagonistic groups in the classroom that have a lot of difficulty dialogue? On the one hand, certain noisy evangelical groups, biblical literals, contrary to any arguments that might supposedly attack religion. On the other hand, the non-religious, who are more connected to the scientific approach, often hold a negative perception of the religious, considering those who deny scientific evidence to be backward and harmful to society (Silva, 2022).

The concept of ‘conflict’ between religion and science is not monolithic but varies across societies and educational contexts (Plutzer, Branch, Reid, 2020). Understanding whether this tension arises from doctrinal interpretations, educational policies, or sociocultural dynamics is essential for formulating strategies to address it.

This article aims to bridge the divide between science and religion in the teaching of biological evolution, emphasizing the compatibility of the Darwinian framework with a theistic worldview. It seeks to explore how the concept of God can be integrated into discussions about the evolution of the universe, life on Earth, and human development, without compromising the foundational principles of Darwinian theory. By finding common ground and highlighting areas of convergence, educators can foster an environment where scientific and religious perspectives coexist, enriching students’ understanding of both domains. In doing so, it is possible to avoid the conflicts that force students to choose between accepting evolutionary theory with its fundamental principles and maintaining their faith.

METHODOLOGY

This study employs a qualitative case study approach, focusing on illustrative examples from students with strong religious convictions. These cases aim to explore the effectiveness of strategies designed to bridge the perceived gap between religious faith and evolutionary science. This article seeks to identify, in an objective way, at which moments of the history of the universe, of life and of humanity, can one conceive the presence of God, without denying any scientific presupposition, especially evolutionary Darwinism. An attempt was made to avoid the trap (Collins, 2003), as the supporters of Intelligent Design often fall into, to place the divine figure to fill gaps in the fossil record, which eventually will be filled by science. In this article, we have attempted to point out spaces that science will not be able to provide an inescapable explanation for a specific phenomenon, and then suggest to those believers of intelligent design that it is possible to imagine the divine figure in these spaces.

These suggestions have only educational value for groups with strong religious affinity. There is no intention of announcing any new discovery of phenomena as trumpeted by some supporters of Intelligent Design (Behe, 1996). I do not want to find the place of God in the universe, nor to affirm the existence of God or to deny it. In this exercise, I am not suggesting that science has the role of proving the existence or not of God, but having proved the facts and mechanisms of biological evolution, I am suggesting that we must find educational ways to teach science without a direct confrontation with religion in order to avoid creating an environment necessitating students to choose a “side”.

This article emerged from the realization, after years of teaching science and biology at the basic, secondary, and higher levels of education in Brazil, that I did not achieve my goal of teaching biological evolution to the students with strong religious convictions, and more concerningly, my students who became teachers. I reflect that I helped to spread an unnecessary and pernicious conflict, perhaps alienating good religious students from science and vice versa. As an educator, I now perceive the need to find ways to offer students with strong religious convictions a way to find points in the history of the universe and life, in which they can glimpse a Creator. This must be done without giving up, even a millimeter, the scientific assumptions have already been discovered and proven. This is a great challenge, which I pursue through specific examples, to help teachers and future teachers who deal with this issue personally and in dealing with their students all over the world.

Here, I also describe in an illustrative way some personal cases of relative success in teaching biological evolution at a Brazilian university, using this form of approaching science and religion, that is, seeking to demonstrate that conflict is unnecessary and harmful to the educational process. I present what happened with two students from a biology teacher training course, who studied Evolution, being deeply religious Brazilian evangelicals, very refractory to the learning of Darwinian evolution. I also show the case of a nursing student, who studied the disciplines of Genetics and evolution, and was also deeply religious, apparently more open to learning the subject of biological evolution, but with a unique characteristic: he was and is an evangelical pastor. The biology students are indicated with the letters “A” and “B”, the nursing student is referred to as “C”.

Student A, for example, was raised in a conservative evangelical community, with regular participation in church services and theological studies since childhood. Despite attending public, secular schools throughout her education, her family and religious community maintained a strong influence, emphasizing creationist views and positioning religion as the central axis of her worldview. This background contributed to her initial strong resistance to any dialogue that sought to integrate science and religion.

Student B, also evangelical, shared a similar trajectory by attending public, secular schools, but was equally shaped by a family environment that positioned religion as a central life-guiding framework. Although she had limited formal theological instruction, her family’s critical stance toward evolutionary theory strongly influenced her initial rejection of the subject.

Student C, an evangelical pastor, also completed his primary and secondary education in public, secular schools, and came from a lower socioeconomic background that valued the opportunity to pursue higher education. Despite his pastoral role and strong religious identity, Student C demonstrated greater openness to dialogue between science and religion, actively seeking ways to integrate his religious beliefs with scientific knowledge.

These cases were selected based on their representativeness of the broader challenges faced by educators in Brazil, where religious diversity and societal expectations create unique dynamics in the classroom. To enhance the scientific rigor, this section will now present contextual information about each student, including their religious affiliation, educational history, and specific classroom experiences that shaped their perceptions regarding evolution. The outcomes highlight the importance of culturally responsive pedagogical strategies.

The pedagogical procedure employed in this study was constructed through years of reflective practice in teaching biological evolution to students with strong religious convictions. The approach was structured to present evolutionary theory with scientific rigor while simultaneously creating cognitive spaces where students could reconcile their faith with scientific explanations. This was operationalized by explicitly highlighting well-established scientific facts about evolution, but also acknowledging areas where science still faces uncertainties, such as the origin of the universe, the emergence of life, and the development of human consciousness. By emphasizing that these scientific frontiers remain open to inquiry, students were encouraged to critically engage with the material without feeling pressured to abandon their religious identities. Throughout the course, different pedagogical tools were employed, including inquiry-based discussions, debates, the use of biographies of key scientists like Darwin, and the incorporation of student-led presentations that explored both scientific evidence and the historical development of evolutionary theory. The classes were designed to foster open dialogue and respect for epistemological diversity, allowing students to voice their religious perspectives in a structured academic setting. This strategy aimed to minimize confrontation and promote a more inclusive learning environment where scientific knowledge could be internalized without generating cultural or psychological resistance.

The qualitative analysis presented in this study is based on teaching experience and three representative cases of students with strong religious convictions who underwent a process of accepting evolutionary theory. While the limited number of cases does not allow for statistical generalizations, the qualitative approach provides valuable insights into how different pedagogical strategies can influence the acceptance of evolution among individuals initially resistant to the concept. Previous research indicates that the conflict between evolution and religion is not homogeneous, as it varies according to cultural, historical, and individual factors (Barnes, Brownell, 2017; Wingert *et al.*, 2023). Future studies should expand this analysis to a larger sample and explore different educational contexts.

RESULTS AND DISCUSSION

For this article, I have selected three moments that can help educators accommodate anxiety that may arise from internal conflict for students with strong religious convictions and beliefs.

The pedagogical strategy proposed in this article emphasizes the importance of presenting science as a dynamic process, in which new discoveries continually refine our understanding of nature. However, it is crucial to avoid the risk of the “God of the gaps” argument (Coyne, 2010) where phenomena not yet explained by science are attributed to divine intervention. Instead, the teaching of evolution can highlight that scientific theories are provisional and subject to revision, without necessarily implying a fundamental opposition between science and faith (Collins, 2003).

The universe is evidence of a process still under construction. However, what was there before?



Figure 1: The origin of the universe (Big Bang)

Source: Artificial intelligence program DALL-E, developed by OpenAI.

Look to the center of this image (Figure 1). Any religious student, aligned with any dogma, can glimpse something divine to supplement this well-grounded scientific theory. Here, I do not intend to affirm that God occupies that space; I only want to show an educational path that avoids the opposition between science and religion. Perhaps even the most convinced atheist agrees that there is something very mysterious at the center of this image, something that science will hardly ever be able to respond to completely. I do not suggest that teachers say that God is there, but that there can be a creator there, that there is no irrefutable explanation of what primordial force existed before the formation of the universe, or to the conditions that led to that initial expansion. In this way, atheists and agnostics would be accommodated, as no specific religion should be promoted in the classroom to respect the diversity of students' beliefs. But what about all the sacred books of religion? Here, it is suggested that they must be interpreted in the light of new scientific discoveries, but that the divine figure could be preserved in the face of these discoveries.

It could be argued that casting possibilities for what would have existed before the Big Bang would be to deny science and all its discoveries, far from it. The idea here is to recognize that there is a space in what would exist before so that believing students can glimpse accommodation. The studies with the most modern tools can estimate the age of the universe with relative safety and a relatively small margin of error (Chaboyer, 1998), but what can science say about what forces could be there on the left side of Figure 1? Atheists and religious believers may draw different conclusions, without losing any of the scientific discoveries about the expansion of the universe or any future discoveries. Even the

well-established theories, such as the Big Bang theory itself, have challenges that, in fact, it is the purpose of a scientific theory to propose explanations where there are phenomena yet to be explained (Ijjas, Steinhardt, Loeb, 2017). This is not to suggest that these challenges are opportunities for religious interpretation, but rather to elucidate the structure and value of scientific theories.

Is there any doubt about the veracity of the Big Bang theory? The current theory provides a consensus explanation for observations made about the universe. Evidence of the Big Bang as an explanation for the structure and evolution of the universe is clear from images produced by several powerful telescopes and other lines of evidence (Chaboyer, 1998). But what was there before? Is it possible to discover without a doubt someday? It will be very difficult...Am I saying that God is to the left of figure 1? No, but I am saying that God could be there. Of course, this only applies to religious thinking and would not invalidate any law or theory of physics or biology. This accommodation would bring in many good students, teachers and future scientists who may be unnecessarily seeing the need to choose between their long-held faith from their family and society and a challenging and spectacular science of origin and evolution of the universe. However, it is essential to emphasize that such representations must remain neutral, avoiding oversimplifications that could alienate students from diverse religious or secular perspectives. Educational materials should be carefully curated to ensure inclusivity.

Beginning of Life on Earth, hypotheses for its origin, no definitive theory...



Figure 2: Origin of Life on Earth

Source: Artificial intelligence program DALL-E, developed by OpenAI.

Figure 2 above shows us that, unlike the origin of the universe, where we have a theory firmly anchored in findings and evidence, in relation to the origin of life on Earth, things are less certain. There are clear clues as to how the origin of life must have occurred, but at this point, we only have hypotheses. Recent advancements provide a broader context for these hypotheses, highlighting both the complexity of the subject and the opportunities for further exploration in educational settings (Dyson, 1999; Ehrenfreund, Charnley, 2000). Although hypotheses are often quite consistent, they frequently conflict with one another (Sutherland, 2016). It has even been considered possible that life might not have an origin here on this planet but could have come here from a place we do not know (Davis, McKay, 1996). Of course, there are more widely accepted hypotheses, including well-grounded, logical, theoretical, and experimental argumentation such as Oparin's hypothesis (Oparin, 1957), but there is no consensus, and the search for answers continues.

Scientists try to model how primordial chemicals may have combined and begun to replicate. These models present possibilities, many well studied, but there is no definitive one that has emerged (Dyson, 1999). Signs of organic molecules have been found in many other places in space, including comets, meteorites, and interstellar space itself (Ehrenfreund, Charnley, 2000). These organic molecules are simply components of those needed to form life; however, no conclusive evidence has yet been found of extraterrestrial life.

Even if we discover life outside our planet, it will not dispel doubts about its origin. The absolute explanation of the origin will not be fully provided simply by discovering extraterrestrial life; it will only be transferred from one place to another. The mystery will continue making possible what I propose in this text.

The origin of life was, is, and probably will be a mystery that eludes even science for quite some time. Today, we know a lot about processes that could eventually have led to the replication of nucleic acids, the formation of cells, and the basis of life on Earth. But ignorance of the primordial factor, the trigger for this to occur, is still immersed in the shadow of the unknown, generating several possible explanations, which may never be fully proven (Gollihar, Levy, Ellington, 2014).

What I propose here is for the professor of science and biology to recognize that there is still much to be understood about the origin of life, not to avoid teaching the most relevant hypotheses, but to allow the more fervently religious students to see room for explanations from their own religion. Should the teacher point to God as this trigger for the emergence of life? Of course not, but show that there are gaps, and that science recognizes that the origin of life requires a very special combination of conditions and chemistry. The atheists, and possibly the agnostics, will continue to accept nature itself as enough explanation, that the immense scale of space and time allows for random combinations acting fantastically, almost mystically, to eventually produce a replicating molecule. But this gap in our knowledge provides a perfect space for those other students, almost 99% in countries like Brazil and the United States, to find their God, whether Christian or from another religion. Does allowing this opportunity conflict with science, with Darwin, or with evolutionary theory? I would say no. I would suggest that allowing a bit of accommodation in the swampy frontier of science for religion, without renouncing any scientific principle, simply points out that there is a strong dose of uncertainty in the origin of life on this planet.

Many may say that I am only filling scientific gaps and will be disregarded as soon as we discover how life came to our planet (Collins, 2003). But the question that I raised is, can we do it without a shadow of a doubt? It may take a long time; meanwhile, it will be very good to have children, young people, and adults avoid putting science on a collision course with their beliefs, for issues that are not even understood by science itself, and run the risk of never being.

But perhaps the act of producing “life” in the laboratory (Smith *et al.*, 2003), as is already an emerging technology in various parts of the world, may deconstruct my idea for scientific education. I would still disagree and suggest that the origin of life remains a good opportunity for accommodation. Atheists will perceive the new technology as a demonstration that nothing supernatural is necessary to generate life, and they may be correct in that conclusion. On the other hand, those more fervent believers may conclude that it was necessary for someone to combine molecules for life to be generated, rather than through randomness. This would be another example of discovering God’s methods in a way that supports one’s faith, that through his religious wisdom, God could have created life. This interpretation would be preserving God’s role, and his existence would be “glorified” by the auspices of science.

Religious individuals may think that I am saying that God explains the origin of life. The answer is no, but only that can explain the origin of life, and that this explanation does not imply the denial of any evolutionary process. Atheists may say that I am hurting the laity of education. By no means have I proposed any religion, no specific God, but I suggest that the teacher can and should keep the flame of the mystery on a theme that science itself considers a mystery and will probably continue to for quite some time. The origin of life on Earth is a process that, despite much experimentation, we cannot fully explain. We can perhaps replicate it, but the actual event of the origin of life on Earth will always be wrapped in some mystery of how it happened and why it occurred on this one small planet in a remote corner of the universe. In this way, we can enable students and teachers to find a noble space for their God, without losing any scientific basis.

The African origin of humanity is supported by fossils and a whole set of evidence, but is capable of interpretations...

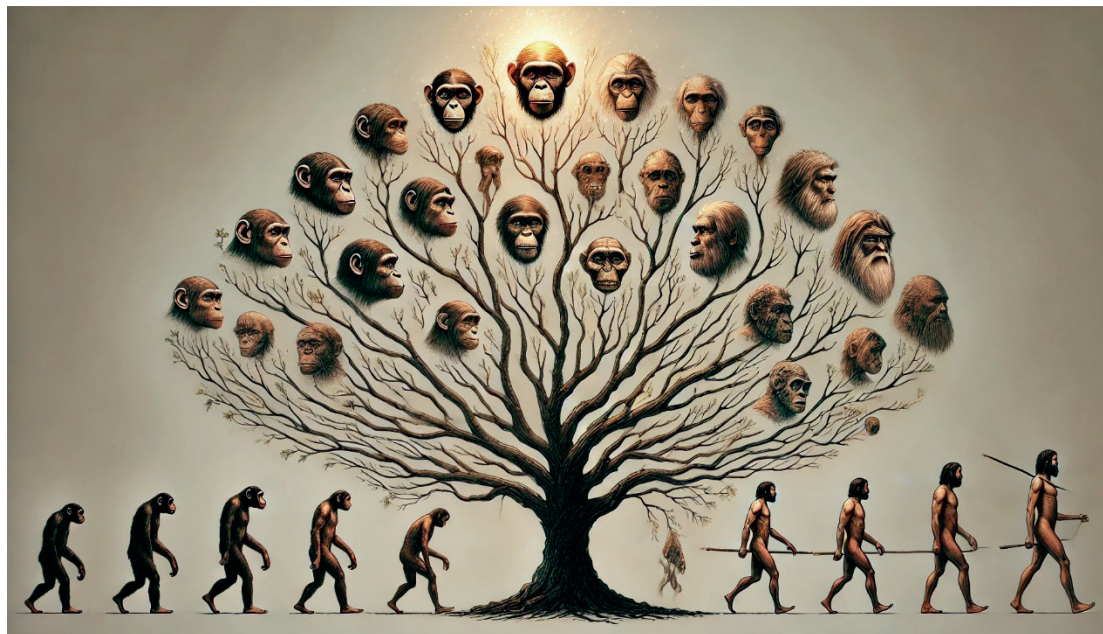


Figure 3: origin of man (or consciousness)

Source: Artificial intelligence program DALL-E, developed by OpenAI.

Is there any doubt about the African origin of humanity? I do not think so. In fact, it is a good time for educators to demolish any kind of racist ideology in the classroom. But what is shown in Figure 3 illustrates that while scientists have elucidated much about the evolution of humans and *Homo sapiens* origin since Darwin's time (Klein, 2009), it has not elucidated all aspects related to the emergence of this species that today dominates the landscape of this planet.

It is important to point out that the linear perception of progression that this image portrays at the bottom, so often used to show human evolution, and that it reveals progression, is a misconception (Lima, 2018), a teleological vision of the purpose of human evolution (Silva *et al.*, 2021), which should be avoided in the classroom, or at least the inadequacy of the image should be explained.

Is there certainty that human species have undergone evolutionary processes like all other species until they reached *Homo sapiens*? Yes, there is no doubt about this in the academic field (Campbell, 2017). But we can glimpse other frontier points of human evolution, which raise reasonable doubts that can provide some consilience in the long clash between science and religion. Especially in the delicate, for the religious, theme of human origin. Research emphasizes the importance of reducing anxiety among educators when addressing the intersection of evolution and religion, offering practical strategies to improve teaching efficacy in religiously diverse classrooms (Dunk *et al.*, 2019).

One suggestion is to briefly discuss how consciousness emerges in that strange biped in the African savannah. There is certainly some mystery as to how that animal, being nothing so special, started to experience its inner world in its totality and started to have the perception of what morally is right or wrong. To be clear, there are other definitions of what consciousness is, and there are many discussions about what defines it (Fuss, 1964).

Atheist students will realize that it was just another prime example of the combination of neural interactions in the highly developed great brain of one species of African bipedal primate. However, this spark can provide a golden opportunity for religious thinkers to see a possible presence of the supernatural and divine. Why does only that animal achieve awareness? Can it simply be due to interactions between neurons? There seem to be many other organisms with sufficiently developed brains, but only *Homo sapiens* seem to have become fully conscious. I do not say that it was God who did it, but he could have done it. His "power" over this one animal could have generated something so singular. It is just a different way to define an emergent property, which denies nothing about mutation and natural selection or

any other aspect of Darwinian evolution. Mutual respect would be preserved, religious people and atheists would not need to attack each other, they would only have a distinct starting point to analyze the emergence of this consciousness. Even within the academic field, many skeptics doubt that science will ever be able to understand human consciousness completely and that a full explanation will remain a mystery (Shermer, 2018).

One can also reflect on when and how human beings, scientifically represented by *Homo sapiens*, began to think about the finitude of life and about the transcendental, or when we would have acquired what religious believers call the soul. Again, it could be that the evolution of certain neurotransmitters, or the unique resulting interactions, or the increased complexity of synapses that produced a primate capable of thinking in such a different way from the other animals. But this moment is seemingly singular, and unseen in any fossil evidence. At some point in human evolution, we became an animal perceiving its finitude, thinking beyond, creating works of art on cave walls. Something new, almost supernatural, happened to this animal.

If it was a spirit incarnated, if a soul was blown into human existence, or if simply the result of neural circuits, does it matter? When discussing how and when this animal happens to have very special characteristics, the teacher can satisfy both sides, showing that in the evolution of humanity arises culture, an almost necessity to create myths, and that this emergence of consciousness has dictated and driven our evolution ever since. Have mutations, genetic variability, and natural selection been involved in this transformation? Certainly (Dobzhansky, 1962), but there may have been something more involved. How can we know? Again, the religious can use this doubt. But can that gap be completely fulfilled? It will be very difficult, and by then, we may no longer have the religious assimilation necessary to reconcile the wonders that science and its disciplines, such as evolution and neuroscience, can explain.

But this proposal could be deconstructed when and if we create fantastic artificial intelligence. If this intelligence displays a conscientious decision maker based on ethics and every other aspect of “consciousness” that defines human beings as unique, this could provide the “silver bullet” for the kind of proposition I make here. I think differently, however. Even if that day comes, we can conclude the exact opposite, as I reasoned for the origin of life. It can be argued that this achievement of science will be so spectacular, so complex, involving so many good scientists and networks of researchers, supercomputers, and all other needed elements, that something similar could not have arisen and emerged in the African savannah. Those who are most in line with science will say that evolution has taken thousands of years of selection to arrive at the capacity of abstraction of the human being. But what is the problem of the religious perceiving it as something beyond imagination? It is, in fact, perceived as such both in the eyes of atheistic scientists and religious students and teachers. Okay, it is salutary to live with those two ways of looking at the world. Neither of them is wrong, they just depend upon different perspectives. And both must be respected, without denying the scientific discoveries that have already been made and are still to come.

To illustrate this way of accommodating science and religion in Biology classes, I report three cases that I believe have been successful in this approach (Silva, 2022a). Student A, an evangelical in the biological sciences higher course, a future biology teacher, was resistant from the first day of school to the theme of the origin of life and evolution; the theme irritated her, and she felt confronted when the subject was treated “only” scientifically. Evidence from the classroom suggests that the clash is useless and counterproductive, as it only creates more animosity and distances the religious student from the scientific field. Even worse is bringing that student’s religion to science and treating it as such, because the hybrid is suffering, and we must remember that a classroom is a mosaic of different religious or non-religious perceptions.

I decided from the beginning of the approach to the controversial themes to show that science has irrefutable evidence that evolution occurred, coming from different academic fields, but that we have some gaps, as in the origin of the universe, in the origin of life, and human consciousness.

In this process, it was essential to demonstrate to the students the broad and robust set of evidence supporting the evolutionary process, moving beyond superficial arguments. The historical record of the Earth, documented by fossil sequences that show gradual transformations of species, was systematically presented (Gould, 1981). Comparative anatomy and molecular biology provided irrefutable examples of shared evolutionary ancestry, including vestigial

structures in the human body and genetic similarities between distinct species (Urry *et al.*, 2017). Laboratory experiments, such as the observation of bacterial resistance to antibiotics and the real-time evolution of viruses, were explored to highlight that evolution is an observable and ongoing process (Lenski *et al.*, 1991). Furthermore, the phenomenon of viral evolution, especially in the context of emerging diseases and pandemics, offered contemporary, tangible examples that directly connected science to the students' daily lives (Baker *et al.*, 2022; Davies, Davies, 2010; Silva, 2021). In addition to scientific data, I emphasized the historical and current positions of scientists who successfully reconciled their religious beliefs with evolutionary science. Darwin himself, in several writings, did not perceive an absolute incompatibility between science and faith (Darwin, 1887). Presenting these perspectives helped the students understand that accepting evolution does not necessarily imply abandoning their religious identities.

I cast doubt, and that space could be filled according to the belief, or the absence of it, of each of the students, without hurting or making an impact. Still, on the other hand, all the pillars of evolutionary theory and science would be preserved. The long-term result, over the course of the four years of the course, was better than I could have predicted, at the end of the course this student chose to do her final work on teaching evolution in high schools, a clear sign of accommodation of the theme before her religious belief.

Student B, also evangelical and studying to be a biology teacher, showed resistance to Darwinian theory in the first classes, although not as forcefully as Student A. She claimed that there was no evidence of evolution and that it would be "just" a theory, it was necessary to explain initially that "theory" in science is different from common sense and that biological evolution is very well grounded. Then I developed the approach to scientific gaps, on which each one can base their personal beliefs. Again, the result was surprising. This student was accepting the evidence of the evolutionary process and understanding it. In her final year in high school, this evangelical, initially anti-evolutionist, decided to teach classes on biological evolution. I recognize that this choice surprised me.

Student C, an evangelical pastor and a future nurse, curious about science, did not present any significant resistance to the presentation of evolutionary theory, but he did not believe much in the evidence shown in class. Once again, I presented the scientific doubts that still exist, I discussed that each one of us could perceive these gaps according to their perception, and I felt a certain relief on the part of the student. However, in this case, an event caught my attention: the student participated in a work presentation, in which he spoke about Darwin's life and his theory, based on one of his biographies, which I lent to the group, a pleasant surprise: an impeccable presentation on the evolutionist's biography and work by a Brazilian evangelical pastor. The student asked me for the book as a gift, as he was impressed with the life and work of the English scientist, and said that he never imagined that evolutionary theory would not be contrary to religion. Therefore, it is a clear example that much of the rejection of evolution comes from ignorance and bad information, from those who want to foment the conflict between science and religion in educational environments.

Given the socio-cultural complexity of evolution education, teachers must adopt culturally competent pedagogical strategies to navigate religious resistance effectively (Barnes, Brownell, 2017). Below are three practical recommendations for educators facing challenges in teaching evolution in religiously diverse classrooms:

1. Framing Evolution as a Scientific Consensus, not a Belief System:

Educators should clarify that acceptance of evolution is not equivalent to religious disbelief. Presenting evolution as a scientific explanation supported by extensive evidence, rather than a competing worldview, reduces perceived conflicts with faith.

2. Using Inquiry-Based Approaches to Encourage Critical Thinking:

Encouraging students to analyze evidence themselves rather than simply presenting evolutionary theory as fact can foster greater engagement. Inquiry-based learning allows students to evaluate scientific arguments without feeling pressured to abandon their personal beliefs (Scott, 1999).

3. Highlighting the Diversity of Religious Perspectives on Evolution:

Many religious traditions, including Catholicism and mainline Protestantism, do not reject evolution (Gould, 1997; Lamoureux, 2009). Teachers can present historical and contemporary examples of religious figures who support evolution, demonstrating that faith and science are not inherently opposed.

This article attempts, modestly, to suggest educational avenues for mitigating this clash in science and biology classes, which alienates students with more fervent beliefs from one of the most solid and fundamental concepts in the

scientific field, biological evolution. Future studies should explore additional socio-cultural dimensions influencing the acceptance of evolution, as well as the effectiveness of educational interventions in diverse settings. By doing so, educators can develop more nuanced approaches to fostering harmony between science and faith.

It is important to acknowledge that the cases presented in this study are qualitative in nature and, therefore, do not aim to provide statistically generalizable conclusions. Rather, these illustrative cases offer valuable insights and preliminary evidence that can inform future research. The findings presented here should be interpreted within the context of their specificity, recognizing the influence of individual, cultural, and educational variables. Nevertheless, the experiences reported contribute to the ongoing discourse on effective pedagogical strategies for addressing the intersection of science and religion in evolution education. Future studies employing broader, mixed-methods, or longitudinal designs are encouraged to validate and expand upon the observations discussed in this article.

CONCLUSIONS

This article did not intend to resolve the complex tension between religious thought and scientific fields in the classroom, but rather to highlight three key moments in the evolutionary history of the universe, life, and humankind that can be explored to create the prospect of reconciliation. These three dimensions – the origin of the universe, the emergence of life, and the development of human consciousness – represent fundamental questions that remain open to further scientific exploration while also allowing room for philosophical and theological interpretation.

First, regarding the origin of the universe, scientific theories such as the Big Bang provide a robust and well-supported explanation for cosmic evolution. However, the fundamental question of what preceded this event remains unanswered. While atheists may view this as a mere physical process governed by yet-unknown laws, religious individuals may see an opportunity for divine presence in this moment of creation. Rather than promoting a “God of the gaps” argument, educators can use this unknown frontier to illustrate the limits of current scientific knowledge, fostering an open discussion that respects different worldviews without compromising the integrity of scientific teaching.

Second, the origin of life remains an area of scientific research with several competing hypotheses but no definitive consensus. While naturalistic explanations, such as abiogenesis and prebiotic chemistry, offer plausible models, the precise mechanism that led to the transition from non-living matter to self-replicating biological systems is still under investigation. By acknowledging this scientific uncertainty, educators can provide a space where students of faith do not feel compelled to reject evolution outright. This approach does not involve teaching religious explanations in the science classroom, but rather recognizing that science and religion can coexist without direct confrontation, allowing students to form their own interpretations.

Finally, the emergence of consciousness presents one of the most profound philosophical and scientific challenges. While evolutionary biology, neuroscience, and psychology provide substantial insights into how cognitive abilities developed in early hominins, the precise mechanisms underlying self-awareness, abstract thought, and moral reasoning remain elusive. Some may argue that consciousness is a purely emergent property of neural complexity, while others may see it as evidence of a divine spark. In education, this ambiguity can be leveraged to demonstrate the richness of scientific inquiry while also acknowledging the diverse interpretations that students may hold, facilitating a more inclusive and respectful discussion.

The aim of these proposals is not to impose a particular perspective but rather to demonstrate that science and faith are not necessarily incompatible. It is crucial to move beyond a binary framework where students feel forced to choose between religious beliefs and scientific knowledge. Instead, fostering critical thinking, open dialogue, and scientific literacy allows students to appreciate the empirical foundations of evolution while also respecting their personal and cultural backgrounds.

Future studies should explore the long-term effectiveness of these pedagogical strategies, assessing their impact on students’ acceptance of evolution and their engagement with science. Additionally, interdisciplinary research involving science education, cognitive psychology, and sociology could further refine approaches that promote scientific understanding without alienating religious students.

DECLARATIONS

- Availability of data and materials: No data and materials.
- Competing interests: No competing interest statement.
- Funding: No funding.
- Authors' contributions: Hesley Machado Silva participated in all stages of the article's production.
- Acknowledgements. No acknowledgements.
- No ethics committee approval required.
- Consent to participate in the article

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