






## Religiosity and teachers' acceptance of the Big Bang Theory

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### ABSTRACT

The creation of the world is a thematic content that intrigues students from a young age. The Big Bang Theory, one of the most prevalent theories about the world's creation, is not elaborated on in Greek schools while teachers provide subjective answers to frequent questions about the creation of the universe and the existence of life. The present study investigates the perceptions of in-service primary teachers to further understand the acceptance of the Big Bang Theory and their attitude towards teaching it. The results show that the more religious the participants are, the less they accepted the theory and the less willing they are to teach it in a classroom environment. Although it is argued that faith and science are two sides of the same coin that are complementary and not mutually exclusive, the religiosity of teachers acts as a stumbling block in the educational process. The distrust towards the Big Bang Theory probably under the thought that their faith is at risk affects their teaching choices.

**Keywords:** acceptance, Big Bang, religiosity, teachers

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## INTRODUCTION

Undoubtedly, in the last two decades, cosmology research, detailed observations, and computer simulations have revolutionized the understanding of the origin, evolution, and structure of the universe (Novotny & Svobodova, 2017). Science has made remarkable progress in understanding the universe's past and predicting its future. With advancements in technology and methodologies, it is now possible to glimpse into the universe's distant past and make informed projections about its future. This not only provides insight into the workings of the universe but also helps us better understand our place in it.

The integration of current cosmology topics into K-12 education has been emphasized as a crucial step in advancing students' scientific literacy. Educational resources such as the framework for K-12 science education (NRC, 2012) and the next generation science standards have emphasized the importance of exposing students to cutting-edge knowledge in cosmology and other fields of science. This not only helps students stay informed about the latest developments in their field of study but also equips them with the skills necessary to become lifelong learners and critical thinkers. Integration efforts have indeed been made in the primary or secondary science curricula of several countries such as Brazil (de Menezes, 2004), Ireland (NCAA, 2015), Nigeria (Igbokwe, 2015), the United Kingdom (King & Mannion, 2008), and the United States (Schleigh et al., 2015).

Greek primary school curriculum mainly focuses on the basics of earth science, including the daily alternation of day and night, the

seasonal transitions, and the planetary system. However, it does not delve into more advanced topics in astronomy. This narrow focus may limit students' exposure to the wider field of astronomy and limit their understanding of the universe beyond our planet. Unfortunately, Greek primary school curriculum falls short in providing a comprehensive education in cosmology by not addressing the scientific explanation of the universe's creation. The term "universe" is referred for the first time in a physics course in 6th grade solely to introduce the changes that the environment undergoes introducing the concept of energy. Specifically, the textbook states that:

According to what we know today, the universe came from a magnificent energy-to-mass transformation almost 14 billion years ago. Since then, our world has been constantly changing (Institute of Educational Policy, 2023c, p. 12).

In secondary school students are informed in a geography course about the age of the Earth and the period that human beings appeared on it (Aslanidis et al., 2015). Astronomy is still available as an elective course in upper high school, but its implementation in each school depends on whether the minimum number of students is reached. This contrasts with the references made in the compulsory religious education course throughout the school years, which refers to the creation of the world by God. Religion and science are described as two circles that are adjacent and not conflicting with each other (Carr, 2008; Gurukkal, 2019; Roederer, 2007). In the education textbook of the religious course of the second grade of Greek upper high school, there are indeed sections dealing with this relationship:

“Science investigates the mysteries of creation, dealing with the epistemic, while Religion deals with the mystery of the Creator, the supersensible [...] a dialectical relationship [...] aiming the conquest of truth” (Institute of Educational Policy, 2023a, p. 21).

Students learn about the creation of the world at a very early age and continue to be taught the Old Testament Scriptures about the creation of the world up to secondary education. In the 3<sup>rd</sup> grade of elementary school, it is stated in the textbook (in the section “our world, a jewel”) that “nature and the environment, the world that surrounds us and in which we live, is God’s creation” (Institute of Educational Policy, 2023b, p. 110). These formalities may cause confusion or foster misconceptions (i.e., ideas and beliefs that people construct as a way to make sense of the world) (Duit & Treagust, 2003) to an evolving mind since they differ from the consensus of the scientists.

It is evident that the exploration of the relationship between science and religion, with the goal of finding the truth, is not equally emphasized in textbooks.

## BARRIERS FACING THE EDUCATORS AND BARRIERS THEY RAISE

Topics like the creation of the universe or the origin of life are inherently interdisciplinary and as such, involve philosophical and religious questions. This makes them difficult to study from a purely scientific perspective, even for individuals studying in science departments (Kragh, 2011).

Students studying science education have diverse ideas about the Universe, its creation, and the Big Bang (Aretz et al., 2016; Prather et al., 2009; Smulsky, 2014; Trumper, 2001c). Trumper (2001a, 2001b, 2001c) studied the alternative ideas of middle school students, high school students, and teachers with no prior teaching experience and found similar results regarding their misconceptions. Although many students know about the Big Bang and the universe, they may not have a deep understanding of the topic, and they may struggle to fully comprehend the details of how the Big Bang happened and how the celestial bodies that exist in the universe were created (Aretz et al., 2016). For example, a study conducted in Greece (Petrou, 2010) with first-year physics students found that the students believed that the universe has had the same form since its creation. Moreover, the students were unable to provide definitions of celestial bodies (galaxies, planets, solar systems, stars, the universe) and they could not further analyze the idea of the expansion of the universe and the existence of a ‘center’ of the universe. In-service science teachers are afraid to teach creation and evolution in school (Moore, 2000), with this fear, stemming, mainly, from their insufficient scientific background.

A superficial understanding of science content can limit teachers’ ability to effectively convey complex concepts to students, focusing on memorization of facts rather than understanding, and struggling to explain the underlying principles and connections between different concepts, as in the case of the Big Bang Theory (Brunsell & Marcks, 2009). Confidence and assertiveness are key factors in a teacher’s ability to effectively convey subject matter to students. When teachers lack confidence in their knowledge of a subject, they may be more likely to avoid teaching it or to present the material in a way that is confusing or unsatisfying to students. Instead of shying away from issues related to

religion’s perspective on the creation of the world, science teachers should actively engage students in discussions in order to promote comprehension of what science is, how it differs from religion, and why the creation of the world and evolution is based on science (Alexakos, 2009; Reiss, 2010). Undoubtedly, teaching issues related to Religion in science lessons should be done with special care and objectivity so that teachers do not promote alienation or create confusion (Reiss, 2010).

Many factors hinder the acceptance of scientific theories, such as knowledge of the key concepts of a theory, understanding of the scientific inquiry process, psychological conflicts, religiosity, and the sociocultural environment, among others (Dunk et al., 2019; Oliveira et al., 2022; Weisberg et al., 2018). Even the use of different methodological instruments has been reported as a cause of inconsistent research results when measuring the acceptance of evolutionary theory with the same group of students (Barnes et al., 2019). The interplay between religiosity and acceptance of scientific theories, particularly those that conflict with commonly held religious views, is a complex and multifaceted issue. The impact of religiosity on an individual’s acceptance of scientific theories can be significant. For example, in previous research examining the public opinion about evolution theory in the USA, it is stated that ‘participants with high levels of religiosity and conservative views are more likely to reject evolutionary theory’ (Weisberg et al., 2018, p. 219). Research has shown that religiosity is negatively correlated with the acceptance of evolution (Manwaring et al., 2015; Rice et al., 2011; Wiles, 2014), and educators who accept the theory of evolution are more likely to use it as a central, unifying theme in their teaching (Deniz & Sahin, 2016). Studies are lacking so far as to whether the same applies to the Big Bang Theory, i.e., whether teachers’ religiosity influences their acceptance of scientific explanation and whether this, in turn, shapes their educational choices.

With the current challenges in teaching science (teachers’ hesitancy about the scientific content and lack of knowledge), the potential impact of religiosity on the approach to scientific issues, and uneven informatics provided through textbooks, it is imperative to gain a better understanding of the matter. The aim of this research is to study in-service elementary teachers’ acceptance of the Big Bang Theory. The research questions posed are:

1. What level of the Big Bang Theory acceptance do in-service teachers demonstrate?
2. Is there any correlation between the acceptance of the Big Bang Theory and religiosity?

## METHODOLOGY

### Participants

A total of 282 (212 females and 68 males) in-service primary teachers participated in the present study. The participants were selected by convenient sampling and the sample included teachers from schools located across the Regional Unit of Ioannina. The questionnaire was distributed to them either with a pen-and-paper form or via an online form.

### Instrument

All participants completed a questionnaire consisting of four parts to be classified according to their acceptance of the Big Bang Theory and their Religiosity, as **Table 1** illustrates.

**Table 1.** Participants' categorization scores for acceptance & religiosity

Acceptance of the Big Bang Theory	Religiosity scale
Age of the Earth	Ideology
Process of the Big Bang	Intellectual
Scientific community's view of the Big Bang Theory	Private practice
The evidence of the Big Bang	Public practice
The scientific validity of the Big Bang Theory	

**Table 2.** Dimensions of MABBT & religiosity scale

Acceptance of the Big Bang Theory	Religiosity scale
Age of the Earth	Ideology
Process of the Big Bang	Intellectual
Scientific community's view of the Big Bang Theory	Private practice
The evidence of the Big Bang	Public practice
The scientific validity of the Big Bang Theory	

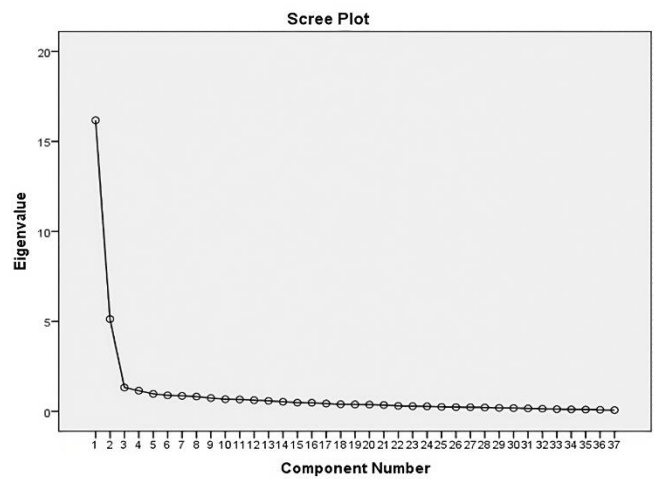
The first part of the questionnaire included questions about the teachers' profiles (age, gender, and religion). It is noteworthy that although an individual's formal religion is decided by the parents by baptizing their infant around one-two years old, most people do not renounce it later in life, but they choose to self-identify differently. Therefore, the results of the religiosity scale accurately represent the reality of faith.

In the second part, a customized MATE questionnaire (measurement of acceptance of theory of evolution), developed by Rutledge and Warden (1999), which measures whether a participant accepts or not the theory of evolution, was used. For the purposes of this study, the term "theory of evolution" was replaced with the term "the Big Bang Theory" and two items that did not fit the context i.e., evolution & humankind were excluded.

The customized questionnaire, hereinafter referred to as MABBT (measurement of acceptance of the Big Bang Theory), consisted of 17 items scored on a 5-point Likert scale ranging from strongly disagree (=1) to strongly agree (=5). The translation of the questions into Greek was carried out by two bilingual speakers. Subsequently, two other bilingual speakers did the re-translation into English. Any minor translation discrepancies were then noted and minor adjustments to the vocabulary were made to ensure content retention and conceptual equivalence, following the guidelines of the International Test Commission (Hambleton, 2001) and Beaton et al. (2000) suggestions.

In the third part of the questionnaire, the 'centrality of religiosity scale' (developed by Huber & Huber, 2012) was used after the addition of five more questions that measures "the general intensities of five theoretically determined basic dimensions of the religious life" (Mantelas & Mavrikaki, 2020, p. 3077). Reliability and validity for both parts have already been tested in the Greek population (Athanasidou & Papadopoulou, 2015; Athanasidou et al., 2012, 2016; Katakos et al., 2011; Mantelas & Mavrikaki, 2020). The dimensions of the MABBT and centrality religiosity scale are presented in **Table 2**.

The last part of the questionnaire consisted of four questions aimed to gauge the teachers' personal beliefs and attitudes towards the two opposing theories, and whether they would choose to prioritize one over the other in the classroom setting. This decision was made as it was deemed important to understand the stance that teachers would take in regards to presenting either the Big Bang Theory or the idea of divine origin when faced with questions regarding the creation of the universe.

**Figure 1.** Scree plot (Source: Authors' own elaboration, using IBM SPSS 28.0)

### Pilot Study

A pilot study was conducted with a sample group of 20 teachers from the target population. The translated questionnaire was evaluated for its suitability for the participants' age group and ability level, with a focus on the accuracy of questions, clarity of meaning, language stability, and phrasing. The study also considered the amount of time it took for participants to complete the questionnaire and any challenges they faced in comprehending the concepts. According to the pilot study's findings, on average, participants required 10-15 minutes to complete the questionnaire. Finally, minor comments were raised, necessary modifications were made, and the final questionnaire was distributed to the participants of the study.

### Statistical Data Analysis

Kaiser-Meyer-Olkin test (KMO) for sampling adequacy and the Bartlett sphericity test (Bartlett, 1950) were calculated. Values greater than .70 for the Kaiser-Meyer-Olkin measure of sample adequacy were accepted (Field, 2018). The internal consistency of the evaluation measure was also examined. The alpha reliability test (Cronbach's alpha coefficients) (Field, 2018) examined internal consistency for MABBT and the centrality of religiosity scale. Moreover, a regression analysis was performed to determine the extent that variables such as gender or religiosity could affect the mean score (Field, 2018).

## FINDINGS/RESULTS

### Descriptive Statistics

Of the 282 participants, 80.9% identified as Christian Orthodox, while the rest (19.1%) described themselves as atheists.

### Exploratory Factor Analysis Results

A principal component analysis with orthogonal rotation (varimax rotation) was performed on the 40 items of the questionnaire. Kaiser-Meyer-Olkin was .959, and Bartlett's test of sphericity was statistically significant ( $\chi^2[780]=9,871.900, p<.001$ ), supporting data suitability for exploratory factor analysis (EFA). EFA results revealed five factors with eigenvalues above 1.00. The retention of the two factors was determined through visual inspection of scree plot. Scree plot revealed

**Table 3.** Summary of items & factor loadings for varimax rotation two-factor solution on questionnaire using principal components analysis

Question	Component	
17. Based on your perception of religiosity, how religious would you describe yourself?	.887	
4. How often do you pray?	.883	
8. How important is it to take part in religious services?	.881	
9. How important is a personal prayer for you?	.880	
2. To what extent do you believe God or something divine exists?	.864	
3. How often do you take part in religious services?	.846	
5. How often do you experience situations, where you feel that God or something divine intervenes in your life?	.844	
14. How often do you pray spontaneously when inspired by daily situations?	.842	
12. In your opinion, how probable is it that a higher power exists?	.842	
7. To what extent do you believe in an afterlife–e.g., immortality of soul, resurrection of dead, or reincarnation?	.817	
13. How important is it for you to be connected to a religious community?	.817	
15. How often do you experience situations where you feel that God or something divine is present?	.807	
1. How often do you think about religious issues?	.755	
19. Religion can answer all the questions and problems of our time.	.750	-.331
6. How interested are you in learning more about religious topics?	.728	
10. How often do you experience situations where you feel that God or something divine wants to communicate or reveal something to you?	.668	
11. How often do you inform yourself about religious questions through radio, television, the Internet, newspapers, or books?	.611	
16. How often, on average, do you practice religious practices (prayer, church attendance, confession, sacrament, etc.)?	.581	
18. 'Historical,' factual elements of Old Testament (mostly chronologies, the way that Earth, plants, animals, humans were created, cataclysm, etc.) are mostly realistic & not symbolic.	.488	-.336
20. I grew up in an environment that was intensely religious.	.410	
10. The Big Bang Theory is not scientifically valid.	.836	
12. The current Big Bang Theory is the result of sound scientific research and methodologies.	.822	
20. The Big Bang Theory is a scientifically valid.	.818	
8. There is a significant amount of data supporting the Big Bang Theory.	.782	
1. The universe is the result of the Big Bang.	.749	
16. The Big Bang Theory is based on real, historical, and laboratory data.	.725	
4. The Big Bang Theory is based on assumptions and not on valid scientific observations and tests.	.709	
5. Most scientists accept that the Big Bang Theory is scientifically valid.	.696	
13. The Big Bang Theory yields testable predictions about the characteristics of the universe.	.673	
6. The available data are inconclusive as to whether the Big Bang occurred.	.672	
2. The Big Bang Theory is impossible to be proved scientifically.	.608	
18. The Big Bang theory explains the variety of features observed in the universe.	.597	
14. The Big Bang Theory cannot be correct since it disagrees with the biblical account of creation.	-.426	.585
11. The age of the Earth is at least four billion years old.	.444	
17. Much of the scientific community doubts whether the universe is changing.	.400	
9. The current form of the universe is the same as it has always been.	.391	
7. The age of the earth is less than 20,000 years.	.388	

**Table 4.** Number of items, Cronbach's alpha, & percentage of the total variance of the questionnaire

Factors	n (items)	Cronbach's alpha	Total variance (%)
Acceptance of the Big Bang Theory	17	.92	42.281
Religiosity scale	20	.97	13.780
Total	37	.88	56.061

a sudden decline in the slope of the curve starting from the second factor, which led to the selection of two factors (Figure 1).

An EFA was re-performed by extracting two factors. Kaiser-Meyer-Olkin was .955, and Barlett's test of sphericity was statistically significant ( $\chi^2[703]=8385.052$ ,  $p<.001$ ). Item 19 was excluded as it had low loading.

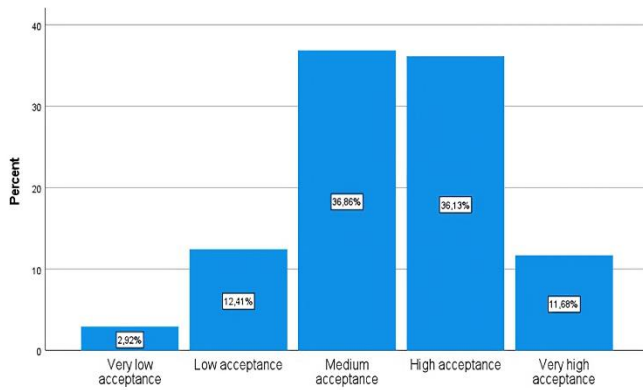
These two factors explained 56.061% of the variance. The items were sequenced according to their factor loading (from highest to lowest) and grouped according to each factor.

Table 3 shows the factor loadings after rotation. The items loaded in the first factor represent the Religiosity scale and explained 42.281% of the variance. Second-factor items represent the Acceptance of the Big Bang Theory and explained 13.780% of the total variance.

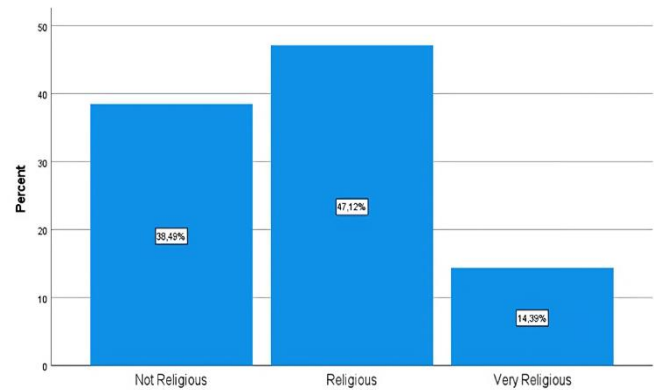
Cronbach's alpha was used to estimate the internal consistency of the questionnaire and each subscale separately, and the results (Table 4) confirmed that the employed questionnaire is reliable.

The Greek primary teachers in the sample revealed a high level of acceptance of the Big Bang Theory according to the scores. From the distribution presented in Figure 2, it is apparent that about 48% of the teachers have high/very high acceptance of the Big Bang Theory, and only about 15% exhibit low/very low acceptance.

Regarding their religiosity level, the teachers of the sample are characterized as having moderate religiosity (Figure 3). The religious and strongly religious participants constitute 61.21% of the total, while 38.5% of the sample is non-religious.



**Figure 2.** Distribution of participants according to their Big Bang Theory acceptance levels (Source: Authors' own elaboration, using IBM SPSS 28.0)



**Figure 3.** Distribution of the participants according to their religiosity levels (Source: Authors' own elaboration, using IBM SPSS 28.0)

**Table 5.** Regression analyses with MABBT as a dependent variable, & gender & religiosity as independent variables

Dependent variable	Independent variables	B	t	R	R <sup>2</sup>	p-value
The Big Bang Theory acceptance	Religiosity	-.249	-8.922	.485	.235	.000
	Gender	2.137	1.537			.126

A regression analysis was performed to explore further the relationship between the independent variables (gender, religiosity) and the dependent variable, the Big Bang Theory acceptance. The test was performed using multiple linear regression techniques.

The results in **Table 5** revealed a moderate negative correlation ( $R=.485$ ) between the Big Bang acceptance score and religiosity score. The predictors explained 23.5% of the variance ( $R^2=.235$ ). Religiosity had a negative b-value indicating a negative relationship. As teachers' religiosity increases, their acceptance of Big Bang Theory drops. On the contrary, gender does not affect the approval of the theory after controlling for religiosity.

Out of the last four questions related to their willingness to teach the Big Bang Theory, it occurred that nearly half (51.8%) of the participants showed a definite willingness, while only 3.5% of them expressed reluctance to discuss the topic of the Big Bang with their students. Similarly, a small proportion of teachers would choose to talk about God in response to such a treaty (11.3%), while 31.6% would not do so at all. The teachers agree with the sense of trying to convince the students of the Big Bang absolutely (23.4%) or somewhat (28.4%), while plenty are undecided (27.3%). Teachers are adamant that the Big Bang Theory should be taught in school (39.7%), while only 2.8% of the teachers disagree with this viewpoint.

## DISCUSSION AND CONCLUSIONS

Scholars argue that there should be a clear distinction between science and religion in public educational institutions (Govender, 2017). In Greece, there is no separation of state and church (Athanasiou et al., 2016), the society is strongly religious (Eurobarometer, 2015), while accountable for the educational policy is the 'Ministry of Education and Religious Affairs'. This, undoubtedly, close relationship between policy and church shapes the context in which decisions, including those related to education, are made.

The analysis of academic textbooks has uncovered a shortage of scientific evidence to back up the theory of the creation of the world. This puts students in a challenging position, as they are exposed to the Big Bang Theory as a scientific explanation, while religious references continue to hold sway. This is not a minor issue, as it has come to the attention of scholars globally, given the fact that many public schools have restricted the teaching of evolution and the Big Bang Theory in science classes (Glennan, 2009).

Despite the strong religious roots of Greek society, the results measuring the level of religiosity show that FOUR out of 10 elementary teachers are classified as non-religious. Given that acceptance of scientific theories (evolution or the Big Bang) is influenced by religiosity, it can safely be assumed that individuals from departments linked directly to science, in opposition to elementary school teachers, would have even higher levels of acceptance and acceptance willingness to teach. For example, a survey conducted in Greece found that 58.2% of Biology students are classified as non-religious, and indeed they have a high acceptance of evolution theory (Mantelas & Mavrikaki, 2020).

Teachers' personal views and understanding of the subjects they teach can impact the quality of their teaching as well as the content and methods they choose (Rutledge & Warden, 2000). It is crucial for future teachers to receive simplified training on subjects such as the creation of the universe, as research shows that even degree holders may lack knowledge or hold alternative views on scientific theories (Brunsell & Marcks, 2009; Kikas, 2004; Moore, 2000; Wescott & Cunningham, 2005). The influence of literal interpretations of religious texts on young learners highlights the importance of teacher knowledge in presenting non-mainstream perspectives. According to the results presented herein, in-service teachers are willing to teach the Big Bang Theory, but they are not keen to answer questions concerning the scientific substantiation of the theory easily or to assess evidence surrounding it. This may justify the result (see **Figure 2**: Medium Acceptance–36.86%) that in terms of acceptance of the theory the dominant attitude is somewhere in the middle.

The intention to teach the Big Bang Theory is considered important as acceptance of the theory does not guarantee that it will be taught in the classroom, considering the number of studies that show that future and current teachers are afraid to teach scientific theories in school. Several studies report that teachers are afraid to teach topics related to the creation of the world and the appearance of humans on earth (Moore, 2000), mainly due to the conflicts such a lesson may bring with students' religious beliefs (Barnes et al., 2017; Brownell et al., 2013) and teachers' reduced ability to manage such a situation (Southerland & Scharmann, 2013). Any attempt of an educator to persuade students based on their personal beliefs, either in the direction of absolute acceptance of sacred texts or outright rejection can be seen as problematic. This is why scholars (e.g., Covaleskie, 2008) believe that even physical education teachers should talk to students about God and be properly prepared to answer questions that focus on religion and relate to the creation of the world and the origin of humans. Reconciling religion and science can lead to better student attitudes towards science and increased acceptance of scientific theories. (Brownell et al., 2013).

### Limitations and Perspectives

The study did not examine the participants' in-depth knowledge and understanding of the Big Bang theory, their understanding of nature of science, and their actively open-minded thinking scale. Other demographics of the participants that may influence the level of acceptance of the theory, such as their financial income, family religiosity, parents' level of education, and the time they spend on informing themselves about scientific issues were also not studied. Finally, other theories about the creation of the world, such as pulsating universe theory could have been also included because not accepting one theory does not necessarily mean a lack of faith in another scientific theory. Future research could be extended to include all of the above.

Teaching practices in which educators avoid adherence to one truth and promote dialogue and discussion about such sensitive topics should also be implemented regarding their impact on scientific knowledge and acceptance of faith. Analyzing interviews with educators discussing the creation of the world and the evolution of humans from various fields such as physical education teachers, religious education teachers, geologists, biologists, etc., could provide useful insight into their acceptance of religion, faith, and science.

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**Declaration of interest:** Authors declare no competing interest.

**Data availability:** Data generated or analyzed during this study are available from the authors on request.

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