

RESEARCH

Open Access



Muslim Indonesian prospective biology teachers' acceptance and typology of the theory of evolution

M. Haviz^{1*}, Roza Helmita¹, Ervina¹, David² and Ika Metiza Maris³

Abstract

Background Muslim Indonesian prospective biology teachers have different views on evolution theory. Muslim prospective biology teachers suspect that differences in their understanding of the theory of evolution stem from their religious beliefs. This study aims to investigate Muslim Indonesian prospective biology teachers' acceptance and typology of evolution theory.

Methods An explanatory sequential design was combined with mixed techniques. Out of 185 potential biology teachers, 153 (16 males and 137 females) completed the questionnaire during the quantitative phase. We interviewed 5 males and 28 females in the qualitative phase to determine the typology of engagement, and all participants filled out an open-ended questionnaire to complete the previous data.

Results The findings demonstrated the validity and reliability of the tools employed, as well as the high degree of acceptance of evolution among Muslim Indonesian aspiring biology teachers. The results also showed that there is a predominant typology of engagement reconciliation among Muslim Indonesian prospective biology teachers, with few explorers and resisters.

Conclusions Muslim Indonesian prospective biology teachers do not differ in their conceptual understanding of theory evolution from their religious beliefs.

Keywords Muslim Indonesian prospective biology teachers, Theory of evolution, Acceptance, Typology

Introduction

Although the theory of evolution is a contentious subject in science curricula worldwide, it was an intriguing topic to examine in biology classes—revising the theory of evolution (Deniz and Borgerding 2018). There are several perspectives on the validity of the theory of evolution, according to earlier studies. For instance, the study looked into 7909 students' endorsement of the theory of evolution in 52 biology classes across the country (Barnes et al. 2021). The study's findings demonstrated that, in American college biology classes, Muslim students are less likely than students of other affiliations to embrace evolution. More research has shown that students who

*Correspondence:

M. Haviz

mhaviz@uinmybatusangkar.ac.id

¹Department of Biology Education, Islamic State University Mahmud Yunus Batusangkar, Batusangkar, Indonesia

²Department of Islamic Education, Islamic State University Mahmud Yunus Batusangkar, Batusangkar, Indonesia

³Department of Mathematics Education, Islamic State University Mahmud Yunus Batusangkar, Batusangkar, Indonesia



© The Author(s) 2024. **Open Access** This article is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License, which permits any non-commercial use, sharing, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if you modified the licensed material. You do not have permission under this licence to share adapted material derived from this article or parts of it. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by-nc-nd/4.0/>.

deny evolution are not limited to Muslims; German Christian students also show similar results (Konnemann et al. 2016; Tolman et al. 2020). The study also highlights the dispute surrounding Darwin's theory of evolution by examining a little-known facet of biology: the historical continuity of Muslim academics' evolutionary beliefs from the 8th century until Darwin's time. The purpose of this work is to improve historical accuracy and provide a deeper comprehension of the evolution theory's scientific background (Malik et al. 2017). Additionally, this paper led to a variety of Muslim intellectuals accepting the theory of evolution.

In the context of the majority of Muslims, this meeting point of intersection between evolution, religion, and education is not yet clear, or there is no real agreement. Several research results show that there are differences in slices in various Muslim-majority countries in the world, such as Indonesia, Saudi Arabia, and Pakistan. Rachmatullah et al. (2018) claim that while Indonesian teachers accept microevolution but reject human evolution, they modify their own goals for teaching development, such as assisting students in appreciating human thought, in order to resolve the conflict between evolutionary theory and religious beliefs. Even educators in schools with an Islamic curriculum think that part of their mission in teaching evolution is to reinforce pupils' religious convictions. A similar explanation can be found in the next article. According to Aini et al. (2020), there is no conflict between evolution and religion, despite the fact that three professors and three aspiring biology teachers disagreed with the idea that evolution is the result of natural selection. Their emphasis on the harmony of evolution and religion is supported by the curricula. Hence, in Indonesia, education is seen as the interface between religion and evolutionary theory. A study on secondary school students' opinions about evolution-based teaching acceptability and learning experiences was carried out by Alanazi (2019) in the Kingdom of Saudi Arabia. The study's findings demonstrate that while examining the meanings and values connected to religion and science, as well as their interrelationship, educators, and learners in Saudi Arabia encounter challenges in using critical and analytical thinking. However, overall, the Saudi students in this study proved supportive of teaching and learning evolution. However, this research does not conclude that there is a clear acceptance of the theory of evolution by teachers and students in the Kingdom of Saudi Arabia. In Pakistan and Canada, the findings varied. Science teachers in these two countries largely accept the evolution of living things, except humans, because human evolution is contrary to their Islamic beliefs (Asghar 2013).

Darwin's gift of natural selection to religion and scientific investigation, according to Ayala (2009), has made the theory of evolution more than just a theory that is

actually rejected by students and teachers (Downie and Barron 2000). This condition contributed to the difficulty students faced in mastering the learning materials, as there exists an ethical norm that prohibits teachers from imposing concepts that students do not believe in (Basel et al. 2014). Additionally, the same research was done, and the findings demonstrated that secondary school pupils possess the information needed to debate matters pertaining to both science and religion. It is believed that these conditions also exist in Indonesian biology classes, particularly those at Islamic universities. Reports about it also have not been found, and it is strongly believed that there is a need to study the acceptance of the theory of evolution by the theory of evolution by Muslim Indonesian prospective biology teachers at Islamic universities.

The typology of student acceptance engagement in the learning strongly corresponds with the acceptance of the theory of evolution because religious education shapes the kind of acceptance and how science interacts with society (Hanley et al. 2014). Furthermore, a previous researcher conducted a study on the integration of science concepts and subjects into Islamic religious learning. The results of this study showed that the availability of information on the rejection and acceptance of science and religion concepts by students is needed to plan the curriculum and learning process (Eminoğlu et al. 2020). Furthermore, the learning characteristics at Islamic universities encompass both science concepts and subjects rooted in Islamic religion, making them inseparable. This condition was assumed to cause different acceptances of the theory of evolution in the biology class for prospective biology teachers. Also, a conflict between the concepts of science and Islamic theology had a potential impact on the student's acceptance of evolution.

The Decree of the Director General of Higher Education of the Ministry of Religion Affairs of the Republic of Indonesia Number 2498, Year 2019, explained that the characteristic of learning at Islamic universities in Indonesia is integrative learning. Lecturers and students in biology education and other science classes at Islamic universities adhered to this decree, committing to develop and implement integrative-based learning (Haviz et al. 2020). Therefore, Muslim Indonesian prospective biology teachers at Islamic universities combined the theory of evolution they had studied with Islamic theology. We refer to this procedure as integration. However, because of the approval and rejection of the integrative curriculum application, the integration process at Indonesia's Islamic universities is moving into a challenging implementation phase (Ali 2020). Students at the Islamic University suspect a conflict between the concepts of science and Islamic theology (Yasri and Mancy 2012). Previous researchers, including Davison (2020), have supported this assumption. Thus, to prove this, it

is necessary to study acceptance and its types, especially the theory of evolution studied by Muslim Indonesian prospective biology teachers.

Acceptance and categorization of the concept of evolution require appropriate and acceptable tools. The Measure of Acceptance of the Theory of Evolution (MATE) study is an illustration of this kind of research, which was conducted to create and validate the instrument (Rutledge and Warden 1999). Five Likert scales were employed in 20 items during the study. The instrument was validated by five specialists in the domains of evolutionary biology, scientific education, and science philosophy. The instrument was then given to 552 responders. The data was analysed using a single-factor model. The instrument's validity and reliability were demonstrated by the results. The research for this study will be conducted using the 20 statement items from the research. Three different types of instruments are used in research on the acceptance of the theory of evolution: the general acceptance of evolution evaluation, the inventory of students' acceptance of evolution, and the measure of acceptance of the theory of evolution (Barnes et al. 2019). In this study, 79 students from four schools in Utah, 120 students from two basic biology courses in Colorado, and 742 students from nine introductory biology courses in Arizona were polled.

Next, the research investigated the typology of student involvement to prove the interrelationship between science and religion. The study used a qualitative method to determine the typology engagement of 200 students aged 14–16 (Hanley et al. 2014). The intriguing aspect of this study involves uncovering and formulating research questions regarding the application of typology, such as “What is your belief about the origin of life on earth?” Then, to determine the theological position, use the following questions (Gallup, 2006) as examples: “*God created man largely in his present form*” (a) “*Humans have evolved over millions of years from simpler life forms*” etc.

The research question is: What are Muslim Indonesian prospective biology teachers' perceptions and typology of the theory of evolution? This study explores Muslim Indonesian prospective biology teachers who have studied evolutionary theory at state Islamic universities in Indonesia. Studies like this, based on the results of a more detailed search, have also not been found and reported. Therefore, we must conduct and document this study in a scientific manner. The result of this study will provide a view about the theory of evolution by Muslim Indonesian prospective biology teachers. The result of this study will also inform us about the relationships between Islam, science, and education. Teachers can use the study's results to modify their teaching and curriculum in the classroom. Also, the study's findings provide more information on how to integrate science and religious theology

into biology education. As a result, the aim of this study is to investigate Muslim Indonesian prospective biology teachers' acceptance and typology of theory evolution. Conducting this study consists of: (a) the quality of the instrument; (b) the acceptance of the theory of evolution; and (c) the typology of the theory of evolution.

Methods

This study used mixed methods, with an explanatory sequential design (Creswell 2014). We chose this design because we expect more comprehensive data collection to be more applicable to research. We collected data in the quantitative phase from a survey on acceptance and the typology of engagement. During the qualitative phase, we collected data using in-depth interviews and an open-ended questionnaire to address the typology of engagement. Both of them will interpret the data on how Muslim Indonesian prospective biology teachers' perceptions and typology of the theory evolution.

The instrument was filled out by 153 (16 male and 137 female) Muslim Indonesian prospective biology teachers at the Department of Biology Education of a private Islamic State University in Indonesia. The participant's age range was 18–23 years old. This study used participants from various grades. This participant has studied in the 7th semester with 41 students, or 26.80%. Participants who studied in the 5th semester are 45 students, or 29.41%. The participants who studied in the 3rd semester are 37 students, or 24.18%. The participants who studied in the first semester were 30 students, or 19.61%. This study used participants with various grade point averages (GPAs). Participants with a GPA range of 3.51–4.00 are 45 students, or 29.41%. Participants with a GPA range of 3.01–3.50 are 58 students, or 37.91%. Participants have a GPA range of 2.76–3.00 and are 34 students, or 22.22%. Participants with a GPA range of 2.51–2.75 are 13 students, or 8.49%. Participants with a GPA under 2.5 are 3 students, or 1.65%.

There are forty-four statements in the Google Form that serves as the survey instrument. Five measuring scales—strongly agree (4), agree (3), uncertain (2), disagree (1), and severely disagree (0)—were used to compile all of the statements in one questionnaire. Acceptance and typology are the factors in the theory of evolution that are used. In terms of acceptance in the theory of evolution, the construct of instruments consists of general evolution, micro evolution, macro evolution, and human evolution. Regarding the typology of engagement in the theory of evolution, the instrument construct includes resistors, confused, reconciled, and explorers as examples.

From July 2021 to January 2022, Muslim Indonesian prospective biology teachers fill out a Google form in the quantitative stage. The researcher invites them

voluntarily and gathers them in a WhatsApp group based on their respective batches. The data of the participants is kept private by the researcher. In the event that the questions and statements are unpleasant for them, participants have the choice to withdraw. Furthermore, the Muslim Indonesian prospective biology teachers submitted the completed questionnaire and carried out an analysis on the created statement items. We conducted in-depth interviews with 5 males and 28 females in 2 h or 15 days during the qualitative phase. During this phase, we also asked participants to complete an open-ended questionnaire that contained the same questions as the interview material.

In the quantitative phase, a confirmatory factor analysis (CFA) test was performed to assess the instrument's quality (Brown 2006). Each compiled statement item's quality has been shown by the test results. The Chi Squared Value of Fit ($p > 0.05 / 0.01$), Degree of Freedom (Df), P Value, and Root Mean Square Error of Approximation (RMSEA < 0.05) calculations have all been made in order to complete the test results. The instrument's reliability was assessed using the Cronbach's alpha test. Additionally, descriptive statistical tests have been run to examine the literacy, acceptance, attitudes, and religious profiles of Muslim candidates for biology teaching positions. To ascertain the link between the variables, a Pearson correlation test was performed. SPSS version 26 was utilised for the analysis of numerical data.

An interview was done during the qualitative stage to ascertain the type of interaction with the theory of evolution. Verification, visualisation, and conclusion drawing from data are examples of qualitative data analysis that is done to acquire or support more trustworthy information. Specifically, the analysis of research results on typology begins with a description of 4 dimensions, i.e., (1) foundation of knowledge; whether the preferred knowledge base of Muslim Indonesian prospective biology teachers is belief-based or fact-based; (2) tolerance of uncertainty; how flexible Muslim Indonesian prospective biology teachers are to tolerance for uncertainty; (3) open-mindedness: a description of the attitude and open-mindedness of Muslim Indonesian prospective biology teachers; and (4) nature of science and religion relationships; whether Muslim Indonesian prospective biology teachers conceptualize science and religion as conflict or harmony.

Furthermore, to analyze the typology, it was conducted based on four types of engagement: resisters, confused, reconciled, and explorers. To describe the engagement, the dimensions of foundation of knowledge, tolerance of uncertainty, open-mindedness, and nature of science/religion relationship were used (Hanley et al. 2014). Furthermore, the four types of engagement will visually represent the position of each group of participants.

Therefore, this section will draw conclusions about the typology of engagement of Muslim Indonesian prospective biology teachers with the theory of evolution.

Results

The quality of instruments

CFA for general acceptance of the theory of evolution

The factor loading score on the CFA test for acceptance of the theory of evolution is between 0.37 and 0.85, according to the results (see Fig. 1; Table 1). Additionally, the results of the CFA test indicated that the instrument's Chi Square, df, P-Value, and RMSEA were 220, 161, and 0.049, respectively. This result proved the validity of the tool used to accept the theory of evolution. N items=20 and a reliability test score of 0.775 were reported by Cronbach's alpha. This result further demonstrated the instrument's dependability. Ultimately, the tool used to support the evolution idea was dependable and valid.

CFA for human evolution

The factor loading score for the human evolution instrument, according to the CFA test results, is between 0.24 and 0.82 (see Fig. 2.a and Table 1). In addition, results from additional CFA tests revealed that this instrument had RMSEA=0.059, df=15, P-Value=0.08758, and Chi Square=22.84. This result demonstrated the validity of the instrument. N items=8 and a reliability test score of 0.593 were reported by Cronbach's alpha. This result further demonstrated the instrument's dependability. Lastly, there existed evidence to support the validity and dependability of human evolution.

CFA for macro evolution

The factor loading score of the thirty-first item on the CFA test instrument for macro evolution is -0.05, according to the results. The scores for the other factor loading items fall between 0.58 and 0.74 (refer to Table 1; Fig. 2.b). Moreover, results from additional CFA tests revealed that this instrument had RMSEA=0.052, df=17, P-Value=0.11064, and Chi Square=24.33. This result demonstrated the validity of the instrument. N items=8 and a reliability test score of 0.769 were reported by Cronbach's alpha. This result further demonstrated the instrument's dependability. Lastly, the macro-evolution instruction was accurate and legitimate.

CFA for micro evolution

The factor loading score for the microevolution instrument ranges between 0.04 and 0.85, according to the CFA test findings (see Fig. 2.c and Table 1). In addition, results from additional CFA tests revealed that this instrument has RMSEA=0.033, df=12, = 0.20400, and Chi Square=13.95. This result demonstrated the validity of the instrument. N items=8 and a reliability test score

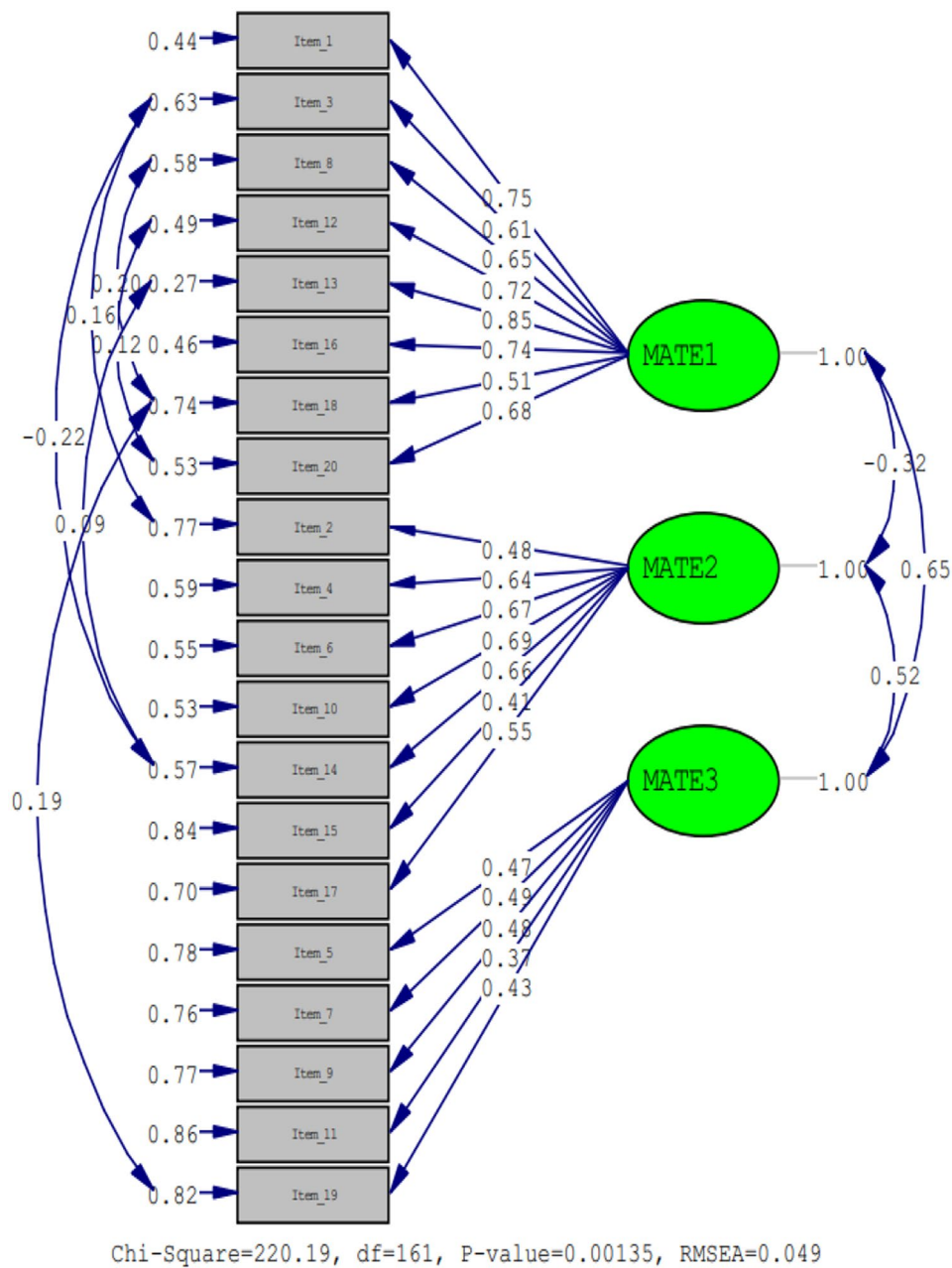


Fig. 1 CFA for general acceptance of the theory of evolution

of 0.722 were reported by Cronbach’s alpha. This result further demonstrated the instrument’s dependability. In conclusion, the microevolution tool demonstrated validity and reliability.

Acceptance of the theory of evolution

As seen in Table 1, Muslim Indonesian prospective biology teachers accepted the theory of evolution based on the concepts of general human evolution, macro evolution, and micro evolution. Each of the four constructs (49.5621±8.11904, 18.0588±4.25385, 18.8301±4.60662,

and 19.7255±4.09145) has a mean and standard deviation ($\chi \pm SD$) displayed in Table 1.

The study’s findings showed that macro- and micro-evolution generally had a higher percentage of prominent, dominating evolution. For example, the general element received a score of 81.05% since there is a substantial amount of evidence in favour of evolutionary theory. This result also showed that the low profile was only given a minimal rating. The same conclusions are shown by the macro- and micro-evolutionary constructions. There were prominent profiles in both constructs.

Table 1 The profil of acceptance toward the theory of evolution

Reason for acceptance	Factor loading	Profile of acceptance		
		High	Middle	Low
General acceptance (Mean ± SD = 49.5621 ± 8.11904)				
The mechanisms that have led to the evolution of modern organisms over millions of years have occurred.	0,75	123(80.4)	15(9.80)	15(9.80)
There is no way to verify the hypothesis of evolution scientifically.	0,48	61(39.9)	48(31.40)	44(28.80)
Modern humans are the result of millions of years' worth of evolutionary processes.	0,61	110(71.9)	20(13.07)	23(15.03)
Instead of reliable scientific observation and verification, the theory of evolution is predicated on conjecture.	0,64	54(35.29)	51(33.33)	48(15.03)
The majority of scientists agree that evolution is a valid hypothesis in science.	0,47	103(67.32)	31(20.26)	19(12.42)
The evidence that is now available is inconclusive as to whether evolution happens.	0,67	55(35.95)	62(40.52)	36(32.03)
The earth is not older than 20,000 years.	0,49	51(33.33)	53(34.64)	49(32.03)
There is a substantial amount of evidence in favour of evolutionary theory.	0,65	124(81.05)	22(14.38)	7(4.58)
Today's organisms are fundamentally the same as they have always been.	0,48	93(62.75)	33(21.57)	24(15.69)
The hypothesis of evolution lacks scientific validity.	0,69	51(33.33)	52(33.99)	50(32.68)
There are at least 4 billion years on Earth.	0,37	62(40.52)	60(39.22)	31(20.26)
The outcome of excellent scientific study and methods is current evolutionary theory.	0,72	109(71.24)	32(20.92)	12(7.84)
Testable hypotheses about the properties of life are produced by the evolutionary theory.	0,85	109(71.24)	36(25.53)	8(5.22)
Since the biblical account of creation contradicts the idea of evolution, it cannot be true.	0,66	72(47.06)	43(28.10)	38(24.84)
The human species that exists today is fundamentally the same as it has always been.	0,41	92(60.13)	44(28.76)	17(11.11)
Factual, historical, and experimental data all support the evolution theory.	0,74	109(71.24)	31(20.26)	13(8.50)
The majority of scientists are sceptical about the existence of evolution.	0,55	90(58.82)	50(32.68)	13(8.50)
The various traits and behaviours seen in living things are explained by the theory of evolution.	0,51	119(77.78)	25(16.34)	9(5.88)
The origin of life on Earth occurred about simultaneously, with very few deviations.	0,43	73(47.71)	63(41.18)	17(11.11)
The hypothesis of evolution has scientific validity.	0,68	85(55.56)	42(27.45)	26(16.99)
Human Evolution (Mean ± SD = 18,0588 ± 4,25385)				
I believe that ancestor species gave rise to new species	0,60	93(60.78)	27(17.65)	33(21.57)
In my opinion, the fossil data used by scientists to back up evolutionary theory is flimsy and unconvincing.	0,77	89(58.17)	39(25.49)	25(16.34)
I believe that the notion that creatures gradually change into new species is supported by the abundance of fossils discovered all over the planet.	0,73	70(45.75)	55(35.95)	28(18.30)
All complex organisms, in my opinion, descended from single-celled ones	0,82	49(32.02)	32(20.92)	72(47.06)
I believe that numerous tiny changes that take place over comparatively lengthy periods of time result in the evolution of new species.	0,58	74(48.37)	44(28.76)	35(22.88)
The idea that one type of organism evolved from a separate ancestral form is, in my opinion, not well supported by observable data.	0,65	88(57.52)	33(21.57)	32(20.92)
I believe that over time, organism variety and morphologies have undergone significant alteration.	0,77	58(37.91)	47(30.72)	48(31.37)
All living things, in my opinion, descended from a single common progenitor.	0,24	91(59.48)	45(29.41)	17(11.11)
Macro Evolution (Mean ± SD = 18,8301 ± 4,60662)				
I believe that because organisms are fully adapted to their natural habitats in their current state, they will not continue to change.	0,73	74(48.37)	50(32.68)	29(18.95)
All biological groups, in my opinion, will keep evolving.	-0,05	59(38.56)	56(36.60)	38(24.83)
In my opinion, there are several instances of organisms going through evolutionary changes within their species (e.g., antibiotic resistance in bacteria and the creation of new strains of the flu virus).	0,74	101(66.01)	38(24.84)	14(9.15)
I believe that species do not change since they were made to be exactly matched to their surroundings.	0,74	73(47.71)	57(37.25)	23(15.03)
I reject the notion that an organism's species will gradually acquire new characteristics.	0,67	100(65.36)	40(26.14)	13(8.50)
It seems to me that the hypothesis explaining how changes within a species can occur is well supported by observable data.	0,14	67(43.79)	59(38.56)	27(17.65)
According to me, species are precisely the same today as they have always been.	0,71	98(64.05)	37(24.18)	18(11.76)
I believe that the theory of evolution, which explains how changes in a species evolve over time, is overwhelmingly supported by evidence.	0,58	54(35.29)	41(26.79)	48(37.91)
Micro Evolution (Mean ± SD = 19,7255 ± 4,09145)				
I believe that because organisms are fully adapted to their natural habitats in their current state, they will not continue to change.	0,08	72(47.05)	56(36.60)	25(16.34)
All biological groups, in my opinion, will keep evolving.	0,75	89(58.17)	40(26.14)	24(15.69)

Table 1 (continued)

Reason for acceptance	Factor loading	Profile of acceptance		
		High	Middle	Low
I believe there are many examples of organisms that have experienced evolutionary changes within their species (e.g., the emergence of new flu virus strains and antibiotic resistance in bacteria).	0,65	97(63.40)	48(31.37)	8(5.22)
I believe that species do not change since they were made to be exactly matched to their surroundings.	0,04	71(46.40)	51(33.33)	31(20.26)
I reject the notion that an organism's species will gradually acquire new characteristics.	0,16	59(38.56)	55(35.95)	39(25.49)
It seems to me that the hypothesis explaining how changes within a species can occur is well supported by observable data.	0,85	106(69.28)	37(24.18)	10(6.53)
According to me, species are precisely the same today as they have always been.	0,22	79(51.63)	52(33.98)	22(14.38)
I believe that the theory of evolution, which explains how changes in a species evolve over time, is overwhelmingly supported by the available data.	0,69	99(64.70)	38(24.83)	16(10.45)

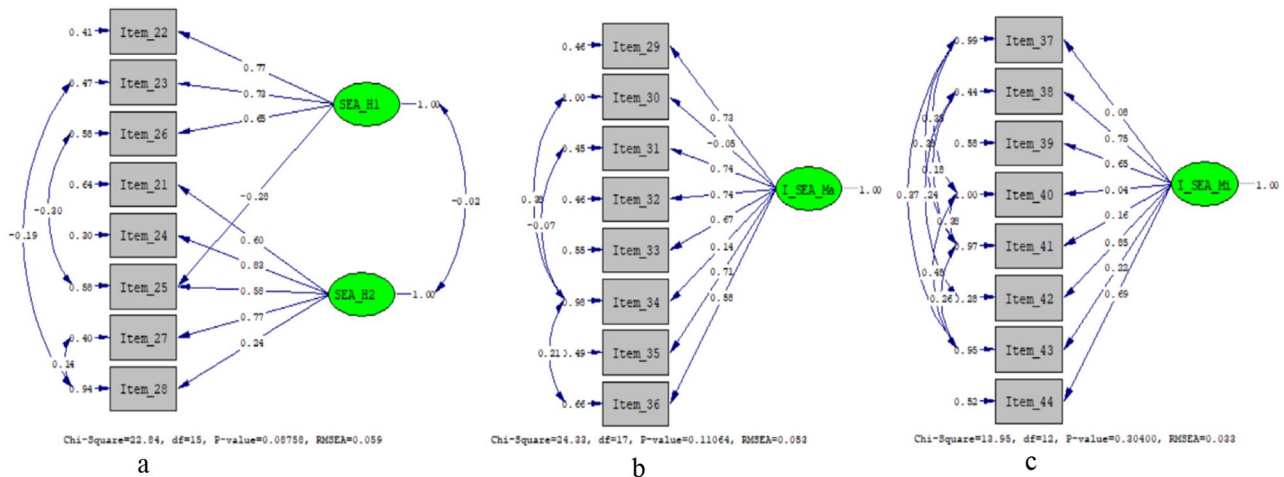


Fig. 2 CFA for (a) human evolution, (b) macro evolution and (c) micro evolution

However, research on human evolution yielded different results. The research findings revealed an even distribution of scores among the three types of profiles, with no single profile showing a dominant result. For example, the study's findings on the human construct showed a high profile with a score of 60.78% for the item "I believe that ancestor species gave rise to new species." For a low profile, the results of the study also showed a high score of 47.06% for the item "All complex organisms, in my opinion, descended from single-celled ones."

Typology of engagement

The open-ended question results showed that Muslim Indonesian prospective biology teachers have good scientific knowledge about the theory of evolution. The following interview excerpts demonstrate this finding.

Question: What do you think is the origin of life on Earth?

Answer: The answer is that throughout millions of years, humans evolved from less sophisticated forms of life.

The results also showed that Muslim Indonesian prospective biology teachers have good theological

knowledge. The responses of Muslim Indonesian prospective biology teachers, when asked about the recognition of theological positions, supported this statement.

Question: Are there any alternative theories as to how life on Earth came to be? If so, could you kindly elaborate?

Answer: According to the Qur'an Allah SWT created the heavens, the earth, and everything in them, including living things.

Question: Which of the following explanations best fits your theory on how humans originated?

Answer: God essentially created humans in their current form.

As previously explained, the description of the typology in the theory of evolution refers to four dimensions: foundation of knowledge, tolerance of uncertainty, open-mindedness, and nature of science-religion relationships. The four dimensions are associated with four types of engagement: resisters, confused, reconciled, and explorers. Figure 3 describes the dimension analysis and engagement typology. The following section describes the results of the typology mapping.

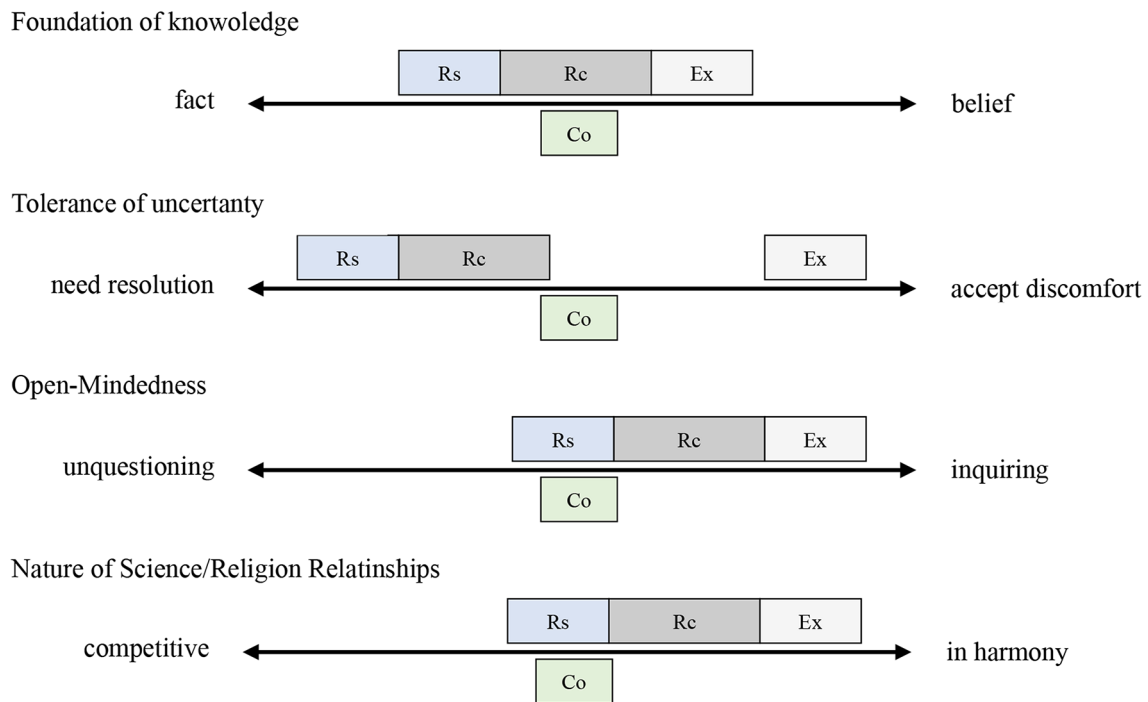


Fig. 3 The type of interaction that Muslim Indonesian aspiring biology instructors have with the idea of evolution (Co= confused; unsure about which to believe based on evidence, or not previously explored; Ex=explorer; freely discuss the subject; Rc =reconciled; take into account both religious convictions and scientific data; and Rs=resistors; decline to discuss a certain idea, typically the scientific data)

Foundation of knowledge

Figure 3 revealed that the majority of Muslim Indonesian prospective biology teachers fell into the reconciliation category, with resistors and explorers following closely behind. The study’s findings revealed that none of the Muslim Indonesian prospective biology teachers were confused. In this dimension, the typology of Muslim Indonesian prospective biology teachers was in the middle position, or between fact and belief. These results indicated that Muslim Indonesian prospective biology teachers have the same strong beliefs and scientific knowledge.

Tolerance of uncertainty

Figure 3 shows that a higher number of Muslim Indonesian prospective biology teachers chose the resolution. Resistance and reconciliation were the types of engagements chosen. This finding showed that the explorer was accepting discomfort. The type of confused still remains in the center of the figure because there are Muslim Indonesian prospective biology teachers who do not choose the confused. These results indicated that Muslim Indonesian prospective biology teachers had more tolerance for the problems of religion and science, in addition to using scientific facts.

Open-mindedness

Figure 3 showed that more Muslim Indonesian prospective biology teachers chose reconciliation, and this type was more uncomfortable. We also found the same result among resistors and explorers. However, the confusion stemmed from the fact that Muslim Indonesian prospective biology teachers did not select this particular type. These results indicated that Muslim Indonesian prospective biology teachers were open-minded about the issues of religion and science. This finding also suggests that Muslim Indonesian prospective biology teachers were open-minded about the issues of religion and science.

Nature of science/religion relationships

Figure 3 showed that more Muslim Indonesian prospective biology teachers chose reconstitution, exploration, and resistance. The three types led to harmony. This finding suggested that there was no doubt in this dimension. This finding also indicated that Muslim Indonesian prospective biology teachers applied religion and science in harmony.

Some snippets of research findings on the typology of engagement are described in the following sections:

Reconciled; respect both scientific findings and religious convictions

According to research findings, Muslim Indonesian prospective biology teachers already have some

accommodation between their religious views and scientific views, allowing them to accept science and religion. The following excerpts from interviews support this finding.

In Islam, early life emerged, starting with the creation of the Prophet Adam and his partner Eve, who later had offspring in pairs. However, scientific knowledge estimates the formation of early life on Earth approximately 4.54 billion years ago. This began with the collision of the outer space planets, which later formed the earth today. On the other hand, when developments occur on Earth, they are also inseparable from the continuing biological and geological changes on this planet. With continued shifts and movements, the early earth creatures grew. Estimates suggest that single-celled organisms dominated the early life of pregnant women. Then, continuing to experience development and adjustment to life on earth contributed to the emergence of multi-celled organisms. In theory, we refer to this process as evolution because it leads to the extinction of the previous creature and its replacement by the next creature or organism. (Student NAA)

Resistors; reject one idea, which is typically scientific data

In this section, Muslim Indonesian prospective biology teachers have an appreciation of belief-based knowledge over facts. This finding revealed their belief in the irreconcilability of scientific and religious perspectives. This is evident from the following interview excerpts:

The first life on earth is known to date back more than 3.5 billion years. Tiny microbes, living underwater in a world drastically different from today, formed this early life. Life on earth emerged during the Proterozoic era. In the Proterozoic era, life began to develop from single-celled organisms into multi-celled organisms, namely eukaryotic and prokaryotic. The evolution of living things, which have existed since ancient times, led to the emergence of the first life. These organisms continue to grow and undergo natural selection, ultimately creating the life we know today. (Student NFR)

The two interview snippets showed that Muslim Indonesian prospective biology teachers have a resistor-type engagement with science. These findings indicated that Muslim Indonesian prospective biology teachers have good scientific knowledge. The religion section yielded similar results. Muslim Indonesian prospective biology teachers also have good religious knowledge. The study's findings also revealed that Muslim Indonesian

prospective biology teachers are also a type of resistor engagement religion. The following interview results further support this finding:

The prophet Adam, who Allah SWT expelled from Eve for breaking Allah's prohibition by eating the khuldi fruit, was the first life on earth. (Student MAM)

In my opinion, life first appeared on earth because of the creation by Allah SWT, which is in accordance with the basis of Islamic law, namely the Qur'an and Sunnah, where the Qur'an has explained how Allah created humans from soil and previously humans came from heaven. Then Allah sent down to earth to be the Caliph and leader of all the worlds. (Student MK)

Confused; undecided between evidence and belief, or never given any thought before

Interesting results have been found in this aspect, where the research results showed that Muslim Indonesian prospective biology teachers do not hesitate to make their choice, whether to choose belief or scientific evidence in science. They are so sure of the choices they have made that they have no doubts about the theory of evolution or the truth of religion.

Explorer; openly engage with topic

The explorer is the part that accepts the challenge of unifying the viewpoints between religion and science. The results showed that in this section, Muslim Indonesian prospective biology teachers chose science and religion to be harmonious and avoided both competing. The results of this study indicate that Muslim Indonesian prospective biology teachers are willing to be openly involved with the topic and are flexible in their views. The following findings from the interviews confirm these results:

At the creation of man, I was firmly convinced that the first man was Adam. But for other living things, I am more inclined to believe in the theory of evolution. (Student ADS)

I believe that the power of Allah SWT appeared on earth in the first life. The source, I believe, is the story of the prophet Adam. Which Allah sent down to earth. And when the prophet Adam came down to earth, Allah had provided plants and animals on earth. (Student AA)

Discussion

The study's conclusions showed that Table 1's factor loading score was higher than 0.1. According to this result, if the coefficient for CFA is higher than a score of 0.1, it is deemed satisfactory and satisfies the requirements (Suhr 2018). Moreover, according to Suhr (2018), CFA characterises the amount of constructions and structural variables that define a step's content or meaning as well as the simplification of associated phases. A Cronbach's alpha score of more than 0.00 is seen in Table S3. Because high alpha values restrict the reliability of the research instrument, the authors employ Cronbach's alpha as a reliability test for two reasons: (a) they utilise it as a statistic to demonstrate the building or adaption of tests and scales for research projects, and (b) high alpha scores provide evidence which is limited from the reliability of the research instrument (Taber, 2018). These justifications allow us to draw the conclusion that the acceptance and typology instruments employed in this investigation are legitimate and trustworthy, indicating their suitability for use in additional research or data gathering.

These results demonstrated that the idea of evolution is widely accepted among Muslim Indonesian aspiring biology instructors. This outcome is consistent with previous studies. The study's findings indicated a connection between a rise in support for microevolution and a decline in support for macroevolution and the evolution of humans (Rachmatullah et al. 2018). This finding, however, differs from those of earlier research, which explained why students in Muslim nations around the world, including Turkey (Deniz et al. 2008), Egypt and Lebanon (BouJaoude et al. 2011), and even Pakistan, where the rejection rate is extremely high (Yousuf and Nadeem 2011), reject the idea that evolution is true.

This study revealed varying results regarding human creation, with Muslim Indonesian prospective biology teachers exhibiting a low profile in this area. Muslim Indonesian prospective biology teachers argue that human creation still refers to and is based on creation that comes from the al-Quran. The results of in-depth interviews also confirmed this conclusion. The results of the typology of engagement with the theory of evolution demonstrate that Muslim Indonesian prospective biology instructors accept the theory of evolution's existence and all of its supporting evidence, with the exception of the question of human creation. Furthermore, they do not perceive a clash between religion and the theory of evolution. Further investigation revealed the same results. While the Indonesian academics in this sample generally believed that evolution and religion could coexist, the survey made clear that creationism was acceptable by pre-service biology instructors and biology education professors who were not familiar with the concept of evolution through natural selection. Rather, they think

that religion and evolution should be categorised in an effort to find harmony (Aini et al. 2020).

Furthermore, the results of subsequent research by Rachmatullah et al. (2022) align with these findings. The results of the study showed that there are a number of obstacles that instructors frequently encounter when attempting to teach the theory of evolution, including internal conflicts that arise between the theory and the teachers' own religious beliefs. Teachers oppose human evolution, yet they are compelled by the national curriculum to teach it, and they see this as a sign of their accountability. They modified their personal objectives to teaching evolution, such as assisting pupils in appreciating human thought processes, in order to resolve the tension between evolutionary theory and religious convictions. Teachers in Islamic institutions, in particular, feel that teaching evolution should include bolstering pupils' religious convictions. The study supports these findings. During the in-depth interview for this study, Muslim Indonesian prospective biology teachers also revealed this information. Muslim Indonesian prospective biology teachers do not compromise with the theory of human creation. They contend that Allah SWT alone created humans and that the theory of evolution does not include them. However, when it comes to other creatures, Muslim Indonesian prospective biology teachers demonstrate a willingness to compromise and accept the evidence of evolution. The level of religiosity among Muslim Indonesian prospective biology teachers, which has a good profile, closely relates to and supports research findings on the profile of religiosity.

This finding shows that there is a harmonious interaction between religion and science. The findings of this study on typology of engagement showed that (a) Muslim Indonesian prospective biology teachers have a dominant type of reconciliation in all four dimensions of typology of engagement; (b) Muslim Indonesian prospective biology teachers do not have type confusion in all four dimensions of typology of engagement; and (c) Muslim Indonesian prospective biology teachers have few types of explorers and resisters. The significance of these findings is that (a) Muslim Indonesian prospective biology teachers have strong religious beliefs and good knowledge of the theory of evolution; (b) Muslim Indonesian prospective biology teachers tend to be tolerant of scientific issues, especially the theory of evolution; and (c) Muslim Indonesian prospective biology teachers tend to choose to seek and find the latest facts from the development of science and religion. Therefore, the research results indicate that Muslim Indonesian prospective biology teachers either moderately accept the theory of evolution or accept specific facts.

Silva et al. (2021) claim that cretinism's ideology has influenced biology teachers' perspectives and mindsets

all over the world. The outcome of this study was further improved by a more thorough examination of the elements that support the hypothesis of evolution. This result emphasises the significance of the interaction between social (society religiosity) and psychological (personal commitment, for example) aspects. For educators, these two elements led to evolutionary reluctance, difficulties, and a path ahead (Newall and Reiss 2023). For the future, the research considers prospective biology teachers' need for reconciliation prior to fully embracing the teaching of evolution (Scharmann 2018).

Conclusion

The findings of the study on the views and typology of the theory of evolution among Muslim Indonesian prospective biology teachers indicate that this theory is widely accepted by these educators. With the exception of accepting the idea of human creation, Muslim Indonesian prospective biology teachers had a high approval profile for the theory of evolution. Prospective biology professors from Muslim Indonesia are not well-known. The typology of engagement profile of Muslim Indonesian prospective biology instructors, when compared to the theory of evolution, indicates that most of them are reconcilers in all four engagement aspects. There are only a few different kinds of resisters and explorers among them, and they are not confused in any of these dimensions.

In terms of implementation, the research's findings also provide proof that integrative education in Indonesia's Islamic universities contributes to the development of a new, peaceful, and tolerant scientific worldview. These results demonstrated a greater preference and application of integration, shedding light on the interplay between science, religion, and education, particularly in the context of learning at Islamic universities in Indonesia. Furthermore, the results of this study support theories about the interrelationship between religious science and learning. One such theory is the reconciliatory interdependence theory of Stenmark, which holds that science and religion can coexist when linked with education (Bigliardi 2014), as well as the concepts of dialogue and integration (Barbour 1990).

Prospective biology teachers from Muslim Indonesia accept the theory of evolution as a potential influence on science education, aiming to foster a harmonious relationship between science and religion in educational environments. Muslim Indonesian prospective biology teachers argue that human creation still refers to and is based on creation that comes from the al-Quran. The findings of the typology of engagement with the theory of evolution have indicated that Muslim Indonesian prospective biology teachers accept the existence of the theory of evolution with all its evidence and that there is

no conflict between the theory of evolution and religion, but not on the aspect of human creation. Future research could enhance the understanding of the interrelationships between the theory of evolution and Islamic law contexts in education, thereby providing comprehensive insights into the interplay between science, religion, and educational practices. Furthermore, the interrelationship of science, religion, and education can be investigated using a learning model to improve the performance of Muslim Indonesian prospective biology teachers.

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12052-024-00206-z>.

Supplementary Material 1

Acknowledgements

The funding for this study came from UIN Mahmud Yunus Batusangkar. The research participants are also thanked, as are the authors, for their support.

Author contributions

MH: conception and design, statistical analysis, data interpretation, prepared figures and tables, manuscript authorship. ER: data collection, manuscript authorship. DV: Statistical analysis, data interpretation, manuscript authorship. RH: data collection, manuscript authorship. IMM: data interpretation, manuscript authorship.

Declarations

Competing interest

The authors declare no competing interests.

Received: 2 November 2023 / Accepted: 9 July 2024

Published online: 27 September 2024

References

- Aini RQ, Rachmatullah A, Harliadi MD. Indonesian pre-service biology teachers' and biology education professors' views on evolution. *Sci Educ*. 2020;29:713–41. <https://doi.org/10.1007/s11191-020-00127-5>.
- Alanazi FH. The perceptions of students in secondary school in regard to evolution-based teaching: acceptance and evolution learning experiences—the Kingdom of Saudi Arabia. *Res Sci Educ*. 2019;51:725–53. <https://doi.org/10.1007/s11165-019-9827-y>.
- Ali N. Integrating science and religion in the curriculum of Indonesian Islamic higher education: a case study of UIN Malang. *Int J Inn Creat Change*. 2020;13(9):948–60. https://www.ijcc.net/images/vol_13/Iss_9/13972_Ali_2020_E_R.pdf.
- Asghar A. Canadian and Pakistani muslim teachers' perceptions of evolutionary science and evolution education. *Evo Educ Outreach*. 2013;6(1). <https://doi.org/10.1186/1936-6434-6-10>.
- Ayala FJ. Evolution by natural selection: Darwin's gift to science and religion. *Theol Sci*. 2009;7(4):323–35. <https://doi.org/10.1080/14746700903239478>.
- Barbour IG. *Religion in an age of Science*. London: SCM; 1990. <https://media.sabda.org/alkitab-2/Religion-Online.org%20Books/Barbour%2C%20lan%20-%20Religion%20in%20an%20Age%20of%20Science.pdf>.
- Barnes ME, Dunlop HM, Holt EA, Zheng Y, Brownell SE. Different evolution acceptance instruments lead to different research findings. *Evo Educ Outreach*. 2019;12(4):1–17. <https://doi.org/10.1186/s12052-019-0096-z>.
- Barnes ME, Roberts JA, Maas SA, Brownell SE. Muslim undergraduate biology students' evolution acceptance in the United States. *PLoS ONE*. 2021;16(8):e0255588. <https://doi.org/10.1371/journal.pone.0255588>.

- Basel N, Harms U, Precht H, Weiß T, Rothgangel M. Students' arguments on the science and religion issue: the example of evolutionary theory and genesis. *J Biol Educ*. 2014;48(4):179–87. <https://doi.org/10.1080/00219266.2013.849286>.
- Bigliardi S. Stenmark's multidimensional model and the contemporary debate on Islam and science. *Theol Sci*. 2014;12(1):8–29. <https://doi.org/10.1080/14746700.2013.868117>.
- Boujaoude S, Wiles JR, Asghar A, Alters B. Muslim Egyptian and Lebanese students' conceptions of biological evolution. *Sci Educ*. 2011;20(9):895–915. <https://doi.org/10.1007/s11191-011-9345-4>.
- Brown TA. *Confirmatory Factor Analysis for Applied Research*. New York: The Guilford Press; 2006. [www.file:///C:/Users/ACER/Downloads/Methodology-in-the-Social-Sciences-Timothy-A.-Brown-PsyD-Confirmatory-Factor-Analysis-for-Applied-Research-Second-Edition-The-Guilford-Press-2015%20\(2\).pdf](http://www.file:///C:/Users/ACER/Downloads/Methodology-in-the-Social-Sciences-Timothy-A.-Brown-PsyD-Confirmatory-Factor-Analysis-for-Applied-Research-Second-Edition-The-Guilford-Press-2015%20(2).pdf).
- Creswell JW. *Research Design; quantitative, qualitative and mixed method approaches*. 4th ed. California: SAGE Publication, Inc; 2014. https://spada.uns.ac.id/pluginfile.php/510378/mod_resource/content/1/creswell.pdf.
- Davison A. Biological mutualism: a scientific survey. *Theol Sci*. 2020;8(2):190–210. <https://doi.org/10.1080/14746700.2020.1755534>.
- Deniz H, Borgerding LA. Evolutionary theory as a controversial topic in science curriculum around the globe. In: Deniz H, Borgerding LA, editors. *Evolution education around the globe*. Cham: Springer; 2018. pp. 3–11. https://doi.org/10.1007/978-3-319-90939-4_1.
- Deniz H, Donnelly LA, Yilmaz I. Exploring the factors related to acceptance of evolutionary theory among Turkish preservice biology teachers: toward a more informative conceptual ecology for biological evolution. *J Res Sci Teach*. 2008;45(4):420–43. <https://doi.org/10.1002/tea.20223>.
- Downie JR, Barron NJ. Evolution and religion: attitudes of Scottish first year biology and medical students to the teaching of evolutionary biology. *J Biol Educ*. 2000;34(3):139–46. <https://doi.org/10.1080/00219266.2000.9655704>.
- Eminoğlu S, Haşiloğlu MA, Keskin B. A qualitative study on the use of the concepts and subjects of life sciences in religion courses. *Mimbar Sekolah Dasar*. 2020;7(3):327–47. <https://doi.org/10.17509/mimbar-sd.v7i3.29183>.
- Gallup. (2006, June 5). Almost half of Americans believe humans did not evolve. <http://www.gallup.com/poll/23200/Almost-Half-Americans-Believe-Humans-Did-Evolve.aspx>.
- Hanley P, Bennett J, Ratcliffe M. The inter-relationship of science and religion: a typology of engagement. *Int J Sci Educ*. 2014;36(7):1210–29. <https://doi.org/10.1080/09500693.2013.853897>.
- Haviz M, Lufri, Maris IM. Assessing prospective biology teachers' (PBTs) perception on thinking as 21st century skill; a case study islamic university in Indonesia. *J Pend IPA Indonesia*. 2020;9(3):319–29. <https://journal.unnes.ac.id/nju/index.php/jpii/article/view/24077>.
- Konnemann S, Asshoff R, Hammann M. Insights into the diversity of attitudes concerning evolution and creation: a multidimensional approach. *Sci Educ*. 2016;100(4):673–705. <https://doi.org/10.1002/sce.21226>.
- Malik AH, Ziermann JM, Diogo R. An untold story in biology: the historical continuity of evolutionary ideas of muslim scholars from the 8th century to Darwin's time. *J Biol Educ*. 2017;52(1):3–17. <https://doi.org/10.1080/00219266.2016.1268190>.
- Newall E, Reiss MJ. Evolution hesitancy: challenges and a way forward for teachers and teacher educators. *Evo: Educ Outreach*. 2023;16(5). <https://doi.org/10.1186/s12052-023-00183-9>.
- Rachmatullah A, Nehm RH, Roshayanti R, Ha M. Evolution Education in Indonesia: Pre-service Biology Teachers' Knowledge, Reasoning Models, and Acceptance of Evolution. In H. Deniz, & L. Borgerding, *Evolution Education Around the Globe*. Springer; 2018. https://doi.org/10.1007/978-3-319-90939-4_18.
- Rachmatullah A, Park S, Ha M. Crossing borders between science and religion: muslim Indonesian biology teachers' perceptions of teaching the theory of evolution. *Cult Stud Sci Educ*. 2022;17:589–624. <https://doi.org/10.1007/s11422-021-10066-4>.
- Rutledge ML, Warden MA. The development and validation of the measure of acceptance of the theory of evolution instrument. *School Sci Math*. 1999;99(1):13–8. <https://doi.org/10.1111/j.1949-8594.1999.tb17441.x>.
- Scharmann LC. Evolution and nature of science instruction. *Evo Educ Outreach*. 2018;11(14). <https://doi.org/10.1186/s12052-018-0088-4>.
- Silva HM, Oliveira AW, Belloso GV, et al. Biology teachers' conceptions of Humankind Origin across secular and religious countries: an international comparison. *Evo Educ Outreach*. 2021;14(2). <https://doi.org/10.1186/s12052-020-00141-9>.
- Suhr DD. Exploratory of confirmatory factor analysis? *Statistics and data analysis. Paper*. 2018:200–31. <https://support.sas.com/resources/papers/proceedings/proceedings/sugi31/200-31.pdf>.
- Taber KS. The use of Cronbach's alpha when developing and reporting research instruments in science education. *Res Sci Educ*. 2018;48(6):1273–96. <https://doi.org/10.1007/s11165-016-9602-2>.
- Tolman ER, Ferguson DG, Mann M, et al. Reconciling evolution: evidence from a biology and theology course. *Evo Edu Outreach*. 2020;13(19). <https://doi.org/10.1186/s12052-020-00133-9>.
- Yasri P, Mancy R. Understanding student approaches to learning evolution in the context of their perceptions of the relationship between science and religion. *Int J Sci Educ*. 2012;36(1):24–45. <https://doi.org/10.1080/09500693.2012.715315>.
- Yousuf Mb, Nadeem A. Awareness and acceptance of evolution and evolutionary medicine among medical students in Pakistan. *Evo Educ Outreach*. 2011;4(4):580–8. <https://doi.org/10.1007/s12052-011-0376-8>.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.