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Original Research

Myths in biology: students' opinion towards vaccination, climate change, genetically modified organisms and evolution

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Abstract

In scientific discourse, the term "myth" is used to describe widespread and demonstrably false beliefs that contradict the current scientific consensus. Due to insufficient biological knowledge and conceptual understanding, various biological myths can arise and persist in the information overload, ultimately influencing public opinion and societal dynamics. To effectively combat and prevent biological myths, it is essential to first understand their origin. The aim of this study was to investigate the opinions of Slovenian secondary school students towards certain biological myths and to explore the relationship between these opinions and students' biological and scientific knowledge, self-assessment of their biological competence, and their interest in science subjects. The study focused on four biologically and socially significant areas included in the primary school curricula: vaccinations, climate change, genetically modified organisms, and evolution. Students with lower self-assessed biological knowledge or with lower grades in biology in lower secondary school were statistically significantly more likely to believe in myths related to climate change and evolution. Interest in science subjects was negatively correlated with scepticism about climate change. The national biology curricula show that climate change and evolution are among the most frequently covered topics, which may explain the associations between biological knowledge and myths. Students attending upper secondary schools with a limited number of science lessons, especially those in vocational education, were more prone to biological myths. The study highlights the critical role of formal biology education and interest in science in curbing the prevalence of biological myths. Given the rapid and complex advances in the natural sciences and their profound impact on daily life and societal development, there is an increasing potential for the emergence of biological myths. It is therefore crucial to ensure high-quality biological education at all levels of schooling.

Keywords

myth, ideas, vaccination, genetically modified organisms, climate change, evolution

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Miti v biologiji: mnenja dijakov do cepljenja, podnebnih sprememb, gensko spremenjenih organizmov in evolucije

Izvleček

V znanosti izraz »mit« uporabljamo za označevanje razširjenih in nesporno napačnih prepričanj, ki nasprotujejo trenutno veljavni znanosti. Zaradi pomanjkljivega biološkega znanja in razumevanja lahko v poplavi vseh informacij nastajajo in obstojijo različni miti v biologiji, ki med drugim vplivajo tudi na družbeno dogajanje. Za uspešno odpravljanje in preprečevanje mitov v biologiji je sprva potrebno njihovo podrobnejše razumevanje. V raziskavi smo želeli ugotoviti, kakšna so mnenja slovenskih dijakov (N=376) do določenih mitov v biologiji ter povezave le teh z njihovim znanjem pri biologiji in naravoslovnih predmetih, lastno oceno biološkega znanja in zanimanjem za naravoslovne predmete. V raziskavi smo se osredotočili na štiri biološka področja, zastopana v učnih načrtih osnovnih šol, ki so družbeno pomembna - cepljenje, podnebne spremembe, gensko spremenjeni organizmi in evolucija. Dijaki, ki nižje ocenjujejo svoje znanje biologije ali so bili slabše ocenjeni pri predmetu biologija v osnovni šoli, statistično pomembno bolj verjamejo v mite o podnebnih spremembah in evoluciji. Zanimanje za naravoslovne predmete je v statistično pomembni negativni povezavi z nezaupanjem v podnebne spremembe. Pregled učnih načrtov za osnovno šolo v Sloveniji je potrdil, da sta podnebne spremembe in evolucija tudi zastopani z največ učnimi cilji med izpostavljenimi področji, kar bi lahko bil razlog za ugotovljene povezave med biološkim znanjem in miti. V srednjih šolah z manjšim obsegom ur naravoslovnih predmetov so dijaki bolj dovzetni za mite v biologiji, še posebej dijaki v vocational education. Raziskava je pokazala, da šolsko biološko znanje in zanimanje za naravoslovne predmete pomembno pri odpravljanju mitov v biologiji. Napredek v naravoslovnih znanosti je hiter in kompleksen ter pomembno vpliva na naš vsakdan in družbene spremembe. Hiter napredek in kompleksnost pa tudi povečuje možnosti pojava mitov v biologiji, zato je potrebno zagotavljati kakovostno biološko izobraževanje na vseh ravnem šolanja.

Ključne besede

mit, predstave, cepljenje, gensko spremenjeni organizme, podnebne spremembe, evolucija

Introduction

The term myth, derived from the Greek word for "story" or "narrative," is frequently used in scientific discourse to denote beliefs that contradict established scientific knowledge. Researchers (e.g., Sismondo, 1996; McComas, 2002) often use the term to describe widely held but demonstrably false ideas. In many cases, myths also reflect broader ideological or cultural worldviews (Douglas, 2003).

The primary objective of science is to understand natural phenomena through explanation, prediction, and intervention. This understanding is achieved through scientific explanations, theories, and models. Due to the inherent complexity of natural systems, scientific models necessarily involve simplifications and assumptions. These simplifications help manage complexity, facilitate understanding, and allow for the application of theoretical knowledge. While all scientific explanations are subject to some degree of uncertainty, this does not render them invalid or untrustworthy. Rather, uncertainty is an inherent feature of scientific inquiry, stemming from the complexity of natural systems and human cognitive limitations. Scientific models are based on idealisations and approximations, while humans often operate with incomplete information about both past and present phenomena (Kampourakis & McCain, 2020).

Research has shown that the application of biological knowledge in real-world contexts is deeply intertwined with social, cultural, economic, and ethical factors (Forbes & Davis, 2008). Socio-scientific issues (SSIs) are characterised by open-endedness, ethical and moral ambiguity, and the possibility of multiple legitimate solutions (Grace & Ratcliffe, 2003). Students often struggle to connect the biological knowledge acquired in the classroom to real-life contexts, resulting in difficulties applying their understand-

ing to everyday challenges (Tsaparlis et al., 2013). Some studies suggest that the breadth of content in science curricula can lead students to focus primarily on memorisation, at the expense of conceptual understanding and critical thinking (Hofstein et al., 2011).

To address these challenges, science education has increasingly embraced the use of SSIs—complex societal questions rooted in scientific knowledge, typically interdisciplinary in nature, and involving ethical and social dilemmas (Kolstø, 2001; Zeidler, 2014). These issues mirror the real-world challenges faced by industrialised societies in the development and application of science and technology (Levinson, 2006). Furthermore, SSIs frequently demand moral reasoning about ethical dilemmas, aspects often underrepresented in traditional science education (Morris, 2014; Tsai, 2018). Integrating SSIs into science instruction can help students better understand contemporary scientific controversies and foster their scientific reasoning skills (Zeidler & Sadler, 2023).

Although public trust in science remains relatively high in many countries, a growing trend of scientific scepticism has been observed, particularly regarding climate change, genetic modification, and vaccination (Rutjens et al., 2018). Such scepticism, often unwarranted, can have serious consequences for public health, economic stability, and environmental sustainability (Thangaraju & Venkatesan, 2019; Bavel et al., 2020). Science scepticism is heterogeneous in nature; its extent varies across scientific domains and among ideological groups (Rutjens & Van Der Lee, 2020).

One significant contributor to science scepticism across multiple domains is the proliferation of conspiracy theories (Rutjens et al., 2021). These theories often claim to reveal hidden truths deliberately obscured by powerful elites and offer seemingly coherent explanations for complex or poorly understood events (Sullivan, 2009). For individuals experiencing a lack of control or uncertainty, conspiracy theories can provide a cognitive framework that helps them reject official narratives and regain a sense of understanding (Douglas et al., 2017). This phenomenon is particularly pronounced when scientific findings challenge individuals' core beliefs or ideological frameworks. Hence, the root of science denial often lies not in the science itself, but in what science symbolises within broader public and political discourse (Rutjens & Bradt, 2018). Many science sceptics perceive science as a threat to their values, beliefs, or worldviews (Rutjens et al., 2021).

In today's information-saturated environment, the rapid spread of both accurate and inaccurate content via the internet, and especially through social media, has led to widespread confusion and mistrust. Exposure to a large volume of conflicting information, especially when accompanied by the intentional or unintentional spread of misinformation, can increase public scepticism and uncertainty (Jerome et al., 2024).

Aim of the Study

This study aims to investigate whether students' biological knowledge and interest in science are associated with their opinions toward socially relevant biological myths in four key domains: vaccination, climate change, genetically modified organisms (GMOs), and evolution. These areas have been identified in the literature about Slovene students as prone to misconceptions and scientific scepticism (e.g., Ambrožič Dolinšek & Šorgo, 2009, 2011; Šorgo et al., 2014; Majer et al., 2019; Strgar & Möller, 2024; Torkar & Šorgo, 2020; Špernjak et al., 2023). These domains are represented to varying degrees in the Slovenian national primary school curriculum. Specifically, eight learning objectives pertain to viruses and vaccination, thirteen to climate change, four to genetic modification, and eighteen to evolution. Based on this distribution, we hypothesise that students' opinions toward these topics may differ depending on the extent to which each topic is addressed during primary and lower secondary education (Primary School Programme. Getting to know the environment. Curriculum, 2011; Primary School Programme. Science and Technology. Curriculum, 2011; Primary School Programme. Science. Curriculum, 2011; Primary School Programme. Biology. Curriculum, 2011)

Research Questions

After completing primary education, students in Slovenia enrol in various types of secondary schools, which differ in terms of duration, academic rigour, curriculum content and the extent of science education. In order to obtain a representative sample of Slovenian secondary school students, this study included first-year students from four types of secondary education programs as defined in the Slovenian education system: lower vocational schools, vocational secondary schools, technical secondary schools, and general secondary (Gymnasia programmes) (Eurydice, 2025). By selecting different types of secondary schools, we wanted to gain the best possible insight into

the population of students attending secondary education in Slovenia. The following research questions were posed:

1. What are students' opinions towards vaccination, climate change, genetically modified organisms (GMOs) and evolution?
2. What is the relationship between students' knowledge of biology and science acquired in primary school, their self-assessed knowledge of biology, their interest in science subjects and their opinions towards vaccinations, climate change, GMOs and evolution?
3. Are there statistically significant differences in the above variables among students in different secondary education programs?

Materials and methods

Sample Description

A purposive sample of first-grade students from a secondary school in the region of Gorenjska (northern Slovenia) was used for this study. The sample included students from four out of sixteen secondary schools in the region. Participants were enrolled in general secondary schools (n = 175), technical secondary schools (n = 123), vocational secondary schools (n = 45) and lower vocational schools (n = 33). A total of 376 students took part in the study, including 171 male students, 185 female students and 20 students who did not specify their gender. In Slovenia, in the same academic year, a total of 24,379 students were enrolled in the first year of secondary education. Of these, 726 were enrolled in lower vocational schools, 5,300 in vocational secondary schools, 10,309 in technical secondary schools, and 8,044 in general secondary schools (Statistični urad Republike Slovenije, 2025).

Data Collection

The data was collected through an anonymous and voluntary survey using a structured questionnaire. In the introductory section, students were asked to report their gender, grade level, school attended and final grades in biology, chemistry and physics in 8th and 9th grades of primary school. In the second section, students assessed their interest in science subjects compared to other subjects using a four-point forced-choice Likert scale: (1) least interested, (2) less interested, (3) more interested, and (4) much more interested, which was used to encourage respondents to indicate a clear preference and avoid neutral responses.

Subsequently, students were then asked to express their agreement with twenty statements representing common biological myths using a five-point Likert scale: (1) strongly disagree, (2) somewhat disagree, (3) neither agree nor disagree, (4) somewhat agree and (5) strongly agree. These statements were divided into four groups, each comprising five items on the topics of vaccination, climate change, GMOs, and evolution. Twenty-one statements addressed whether participants believed in conspiracy theories. In constructing the statements on biological myths, we based our approach on previously conducted research. The statements were developed based on previous research in these four domains (e.g. Marris, 2001; Dolinšek & Šorgo, 2009; Touyz, 2013; Torkar & Šorgo, 2020; Saunders, 2022; Cook, 2025).

The same Likert scale was employed in the final section of the questionnaire in which students self-assessed their biological knowledge across eight different biological domains covered in primary school (knowledge of DNA structure, microbiology, human anatomy, evolution, photosynthesis and cellular respiration, plants, animals). Each domain was represented by two statements. In formulating the statements, we based them on the research by Bahar et al. (1999) and the national curriculum guidelines for science in grades 6 and 7 (Primary School Programme. Science. Curriculum, 2011) and for biology in grades 8 and 9 Primary School Programme. Biology. Curriculum, 2011) were taken into account. Students completed the questionnaire at school during regular lessons. Completing the questionnaire required approximately 20 minutes.

Data Analysis

The data were analysed using both descriptive (frequency, relative frequency, mean, standard deviation, minimum and maximum) and inferential statistics using SPSS software. The average of the final grades in biology and all science subjects for eighth and ninth grades was calculated and used to measure correlations. Each subscale of biological myths, vaccination ($\alpha = .75$), climate change ($\alpha = .70$), GMOs ($\alpha = .60$) and evolutionary theory ($\alpha = .63$), consisted of five items. The average score for each subscale was used in further analyses. The average score for students' self-assessed biological knowledge ($\alpha = .81$) was calculated and employed in measuring correlations.

Spearman's rank-order correlation coefficient was used to examine the relationships between students' interest in science subjects, their average final grades in biology and science in primary schools, their self-assessed knowledge of biology, and their beliefs regarding vaccination, climate change, GMOs, evolution, and conspiracy theories. Differences in students' opinions according to the type of secondary school they attended were examined using the Kruskal-Wallis test and the Mann-Whitney U test. Effect sizes were also calculated ($\eta 2$) (Cohen, 1992).

Results

Interest in Science Subjects, Academic Performance, Self-Assessed Biological Knowledge, and Belief in Biological Myths

Table 1 presents the descriptive statistics related to students' interest in science subjects (biology, chemistry, physics), their final grades in biology and all science subjects during primary school, their self-assessed biological knowledge, and their agreement with prevalent biological myths.

On average, students reported a relatively low interest in science subjects compared to other school subjects (M = 2.42, SD = 0.82), suggesting a below-average level of engagement. The mean final grade in biology obtained during primary school was moderately high (M = 3.77, SD = 0.94), slightly exceeding the average grade across all science subjects (M = 3.65, SD = 0.87). Students' self-assessed biological knowledge was reported at a moderate level (M = 3.56, SD = 0.71).

In terms of agreement with common biological myths, students expressed the highest level of agreement with myths concerning genetically modified organisms (GMOs) (M = 2.86, SD = 0.76), followed by myths related to vaccinations (M = 2.62, SD = 0.92), evolution (M = 2.43, SD = 0.81), and climate change (M = 2.25, SD = 0.81).

Table 2 provides a more detailed overview of the individual statements related to biological myths, categorised into four thematic areas: Distrust of vaccines, denial of climate change, distrust of genetically modified organisms (GMOs) and denial of the theory of evolution. A total of 24% of respondents somewhat agree or strongly agree with the claim that COVID-19 vaccines are not effective and safe for all people, as the vaccine was allegedly only tested on individuals of white ethnicity. In addition, 41% of students somewhat or strongly agree that natural immunity acquired through infection is a better option than immunity acquired through vaccination. Only 24% of respondents somewhat agree or strongly agree with the statement that current climate change is part of the Earth's natural temperature fluctuation cycle and not a consequence of human activity. As many as 48% of respondents somewhat agree or strongly agree with the myths that if cows and chickens consume genetically modified feed, their meat, milk and eggs are also genetically modified. Finally, 35% of respondents somewhat agree or strongly agree with the belief that life on earth was created by a creator or multiple creators.

Table 1. Descriptive statistics for interest in science subjects, final grades in biology and all science subjects, self-assessed biological knowledge and agreement with biological myths.

Tabela 1. Opisna statistika za zanimanje za naravoslovne predmete, povprečno zaključeno oceno pri predmetu biologija in vseh naravoslovnih predmetih v osnovni šoli, lastna ocena znanja biologije ter sstrinjanje z biološkimi miti.

Topic	Mark	N	M	SD	Min.	Max.
Interest in science subjects	ISS	376	2.42	.82	1	4
Average final biology grade	ABG	365	3.77	.94	1	5
Average final grade in science subjects in primary school	AGS	366	3.65	.87	1	5
Self-assessed knowledge of biology	SBK	376	3.56	.71	1	5
Myths about vaccinations	V	376	2.62	.92	1	5
Myths about climate change	CC	376	2.25	.81	1	5
Myths about GMOs	GMO	376	2.86	.76	1	5
Myths about the theory of evolution	E	376	2.43	.81	1	5

Table 2. Detailed Overview of Individual Statements Related to Biological Myths

Tabela 2. Podrobnejši vpogled v posamezne trditve o mitih v biologiji.

Statements		(1)	(2)	(3)	(4)	(5)	M	SD
Myths about vaccinations								
1	Vaccinations are unnecessary because many countries have low infection rates.	30 %	20 %	29 %	12 %	9 %	2.54	1.29
2	COVID-19 vaccines contain microchips.	51 %	11 %	25 %	6 %	8 %	2.17	1.36
3	The COVID-19 vaccine has been proven to cause changes to DNA.	30 %	21 %	28 %	13 %	8 %	2.51	1.27
4	The COVID-19 vaccines are not effective and safe for all people because they have only been tested on individuals of white ethnicity.	33 %	16 %	26 %	11 %	13 %	2.64	1.42
5	Immunity acquired by infection is a better choice than immunity acquired by vaccination. (related to COVID-19).	11 %	13 %	34 %	21 %	20 %	3.27	1.22
Myths about climate change								
6	The current climate change is part of the natural fluctuations in the Earth's temperature and not the result of human activity.	31 %	26 %	18 %	13 %	11 %	2.52	1.34
7	There is no empirical evidence for global warming.	35 %	22 %	34 %	6 %	2 %	2.24	1.08
8	There is no correlation between the average temperature and the amount of CO2 in the atmosphere.	31 %	18 %	39 %	8 %	4 %	2.42	1.13
9	The Earth is indeed cooling, as the growing ice on the Antarctic shows.	55 %	15 %	18 %	5 %	6 %	1.98	1.24
10	Extreme weather has nothing to do with global warming.	48 %	23 %	17 %	9 %	4 %	2.10	1.24
Myths about GMOs								
11	The consumption of genetically modified organisms leads to changes in the DNA of human body cells.	19 %	23 %	35 %	17 %	7 %	2.73	1.15
12	A tomato from your own garden contains no genes, whereas genetically modified tomatoes do.	32 %	17 %	24 %	14 %	13 %	2.66	1.39
13	Genetically modified organisms are merely an instrument used by the authorities to control the global economy.	24 %	18 %	37 %	12 %	8 %	2.69	1.22
14	If cows and chickens consume genetically modified feed, then their meat, milk and eggs are also genetically modified.	14 %	15 %	23 %	30 %	18 %	3.24	1.29
15	GMOs cause the formation of cancer cells and tumours in humans.	11 %	17 %	45 %	21 %	6 %	2.99	1.05
Myths about the theory of evolution								
16	Life on earth was created by a creator/creators.	27 %	10 %	28 %	15 %	20 %	2.93	1.43
17	The human eye is so complex that it cannot have developed by chance through evolution.	27 %	19 %	36 %	10 %	8 %	2.60	1.23
18	All plants and animals have remained unchanged and perfect since the beginning of life on Earth.	56 %	19 %	14 %	6 %	6 %	2.01	1.26
19	Mutations are always harmful; therefore, they cannot contribute to the evolution of species on Earth.	41 %	21 %	26 %	6 %	5 %	2.21	1.20
20	Fossils are not sufficient evidence for the evolution and the relationship of species on Earth.	50 %	25 %	16 %	4 %	6 %	1.99	1.17

*(1) strongly disagree, (2) somewhat disagree, (3) neither agree nor disagree, (4) somewhat agree, and (5) strongly agree.

Association between Interest in Science Subjects, Average Final Grade in Biology in Primary School, Self-Perceived Biology Knowledge, and Belief in Biological Myths

Figure 1 presents Spearman's rank correlation coefficients for statistically significant associations between variables. Students' opinions related to the denial of climate change were significantly negatively correlated with their interest in science subjects compared to other school subjects (r_s = -.21; p < .001), with their self-assessment of biology knowledge (r_s = -.30; p < .001), and with their average final grade in biology in primary school (r_s = -.17; p = .001). Opinions reflecting denial in evolutionary theory were significantly negatively associated with students' self-perceived biology knowledge (r_s = -.27; p < .001) and with their final grade in biology in primary school (r_s = -.12; p = .027). Furthermore, interest in science subjects was negatively associated with belief in climate change myths (r_s = -.21; p < .001). Figure 1 also highlights other statistically significant associations between the variables. Students' self-assessed biology knowledge was positively associated with their final grade in biology in primary school (r_s = .47; p < .001).

A significant positive correlation was also found between students' interest in science subjects and their final grade in biology (r_s = .35; p < .001), as well as between interest in science subjects and their self-assessed biology knowledge (r_s = .31; p < .001). Statistically significant associations were also identified between certain categories of biological myths.

Due to the large number of connections and for the sake of clarity, the diagram does not display statistically non-significant correlations; these include correlations between interest in science subjects and distrust in vaccinations (r_s = -.11; p = .053), distrust in GMOs (r_s = -.04; p = .448), and denial of evolutionary theory (r_s = -.08; p = .109). Between self-assessed knowledge of biology and distrust in vaccinations (r_s = -.03; p = .581), as well as distrust in GMOs (r_s = -.10; p = .062). Between the average grade in biology and distrust in vaccinations (r_s = -.03; p = .556) and distrust in GMOs (r_s = -.01; p = .062). Finally, there was a significant correlation between the overall average grades in science subjects and distrust in vaccinations (r_s = .043; p = .979), distrust in GMOs (r_s = -.11; p = .029), and denial of climate change (r_s = -.13; p = .01).

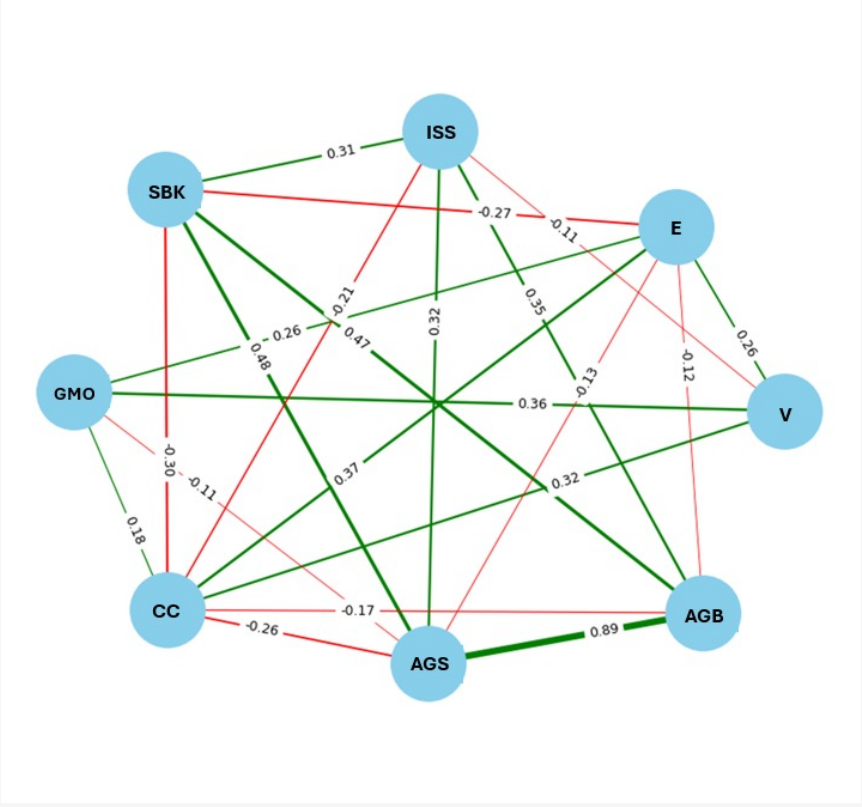

Figure 1. Diagram of the statistically significant correlations (p < .05) between the variables: Interest in science subjects (ISS), self-assessed biology knowledge (SBK), distrust in vaccination (V), denial of climate change (CC), distrust of GMOs (GMO), Denial of evolutionary theory (E), average final grade in biology in primary school (AGB) and average final grade in science subjects in primary school (AGS).

Slika 1. Diagram statistično signifikantnih korelacij (p < .05) med spremenljivkami zanimanje za naravoslovne predmete (ISS), ocena znanja o biologiji (SKB), nezaupanje v cepljenje (V), zanikanje podnebnih sprememb (CC), nezaupanje v GSO (GMO), zanikanje evolucijske teorije (E), povprečje zaključenih ocen pri biologiji v OŠ (AGB) in povprečje zaključenih ocen pri naravoslovnih predmetih v OŠ (AGS).

Students from different secondary school programmes and their belief in biological myths

Statistically significant differences were found in students' opinions towards vaccination ($\chi^2(3, N = 376) = 7.81$; $p = .050$; $\eta 2 = .013$), genetically modified organisms (GMOs) ($\chi^2(3, N = 376) = 7.55$; $p = .056$: $\eta 2 = .012$), climate change ($\chi^2(3, N = 376) = 38.87$; $p < .001$; $\eta 2 = .096$) and evolutionary theory ($\chi^2(3, N = 376) = 23.06$; $p < .001$; $\eta 2 = .055$) across different secondary school programmes. The effect size for climate change and evolution subscales is medium, while for vaccination and GMOs it is low.

No statistically significant differences were observed between students from vocational and lower vocational programs regarding beliefs in biological myths. Students from lower vocational secondary schools expressed significantly stronger agreement with myths about the theory of evolution ($Z = -2.15$; $p = .032$; $\eta 2 = .498$), with a high effect size, than students from technical secondary schools. Compared to general secondary school students, lower vocational secondary school students were significantly more likely to endorse myths related to climate change ($Z = -3.68$; $p < .001$; $\eta^2 = -.40$) and the theory of evolution ($Z = -2.80$; $p = .005$; $\eta^2 = -.40$), with a high effect size for both. Students attending vocational secondary schools were more likely to believe myths concerning vaccination ($Z = -2.57$; $p = .010$; $\eta^2 = -.586$), climate change ($Z = -5.20$; $p < .001$; $\eta^2 = .587$), GMOs ($Z = -2.59$; $p = .010$; $\eta^2 = .586$) and the theory of evolution ($Z = -3.31$; $p < .001$; $\eta^2 = .586$) than students attending technical secondary schools, with a high effect size for all subscales. Furthermore, when compared to general secondary school students, vocational secondary school students showed a significantly greater belief in myths about vaccinations ($Z = -2.57$; $p = .010$; $\eta^2 = .487$), climate change ($Z = -5.82$; $p < .001$; $\eta^2 = -.487$), GMOs ($Z = -2.32$; $p = .020$; $\eta^2 = .486$) and the theory of evolution ($Z = -4.39$; $p < .001$; $\eta^2 = .487$), with high effect sizes for all the mentioned subscales. A comparison between technical secondary school students and general secondary school students revealed that the latter were significantly less likely to believe in myths about climate change ($Z = -2.68$; $p = .007$; $\eta^2 = .487$), and the effect size is large.

Discussion

The results show that, on average, students are the most sceptical about genetically modified organisms (GMOs) and vaccinations. This can be partly explained by the analysis of national curriculum documents, which reveal that topics such as climate change and evolution are covered more systematically in primary and lower secondary science education, Primary School Programme. Getting to know the environment. Curriculum, 2011; Primary School Programme. Science and Technology. Curriculum, 2011; Primary School Programme. Science. Curriculum, 2011; Primary School Programme. Biology. Curriculum, 2011). On this basis, we hypothesise that students in these subjects form stronger evidence-based attitudes and have higher perceived self-efficacy. Perceived self-efficacy plays an important role in the way students engage with and apply scientific knowledge (Živković et al., 2023). Those with higher self-efficacy are more likely to rely on knowledge acquired in formal biology classes when interpreting natural phenomena. In contrast, students with lower self-efficacy tend to accept cognitively simpler, alternative explanations that often lack scientific validity (Carroll et al., 2024). If students have not internalised the necessary scientific knowledge at school, or have internalised it insufficiently, they are more likely to seek information from informal or external sources. Attitudes towards controversial biological topics are also shaped by external influences, including media narratives, religious and cultural beliefs, public opinion and broader worldviews (Janže, 2016; Happer & Philo, 2016). These sources often offer simplistic, emotionally appealing explanations that may not align with the scientific consensus. As a result, misconceptions and pseudoscientific myths persist and spread among the young population. In this context, the role of formal education becomes particularly critical. Schools are expected to provide students with a science-based framework that supports the development of informed, critical and reasoned viewpoints on complex socio-scientific issues (Colucci-Grey et al., 2006).

A significantly higher prevalence of myths is observed in subject areas that are less thoroughly covered in the Slovenian education system or that inherently require a more complex conceptual understanding. In order to critically evaluate the overwhelming flood of information, students need to gain the ability to evaluate sources and think critically (Wilson, 2018). This again emphasises the central role of education in fostering these competencies (Şahin et al., 2015). Students' attitudes are strongly influenced by the perspectives of their teachers. However, research suggests that some teachers themselves exhibit uncertainty about

certain science topics, may deliberately avoid addressing certain topics in the classroom, and sometimes fail to take an objective, science-based approach when teaching controversial topics (Ambrožič Dolinšek & Šorgo, 2009). This reluctance can be attributed in part to the rapid advances in scientific knowledge and constant updates to curriculum content, for which teachers may not be adequately trained. Therefore, it is crucial that teachers receive continuous professional development and that institutional support for teacher training is ensured.

The main aim of this study was to investigate whether and how students' knowledge influences their opinions towards certain biological myths. The results indicate that students have a solid foundation of biological and scientific knowledge after completing primary and lower secondary school, an assessment that is confirmed by both objective measures and students' self-evaluations. The extent to which students are susceptible to biological myths appears to be directly related to the quantity, quality and extent of their knowledge in specific domains (Lindeman & Svedholm-Häkkinen, 2016). This is also supported by the observed correlations between students' attitudes towards biological myths and the type of upper secondary school programme they attend (Aarnio & Lindeman, 2005).

Students with lower average final grades in science and biology in lower secondary school tend to agree more strongly with myths related to climate change, genetically modified organisms (GMOs) and the theory of evolution than students with higher average grades. Similar trends can be observed when comparing students attending different types of secondary school programmes and their beliefs regarding myths. Climate change and evolution are topics that are covered more extensively in primary and lower secondary school curricula, suggesting that students form their attitudes towards these topics predominantly in the school context based on information acquired in formal education. These topics also contribute more to the final grade in science subjects, making academic performance a more reliable indicator of students' understanding in these areas. In addition, students' grades may influence the type of secondary school they attend, which in turn reflects their level of cognitive engagement with these topics. Consequently, students' attitudes toward climate change and evolution are related to academic indicators such as grades and the academic rigour of their secondary school programme. On the other hand, topics that are underrepresented in the formal curriculum, such as GMOs and vaccines, are less likely to have their conceptual understanding captured by school assessment parameters. These topics are therefore more susceptible to the influence of external sources and may be less reliably assessed by school performance indicators.

Conclusions

Emphasising the relevance of biology to global issues, such as climate change, public health, and biodiversity loss, can help students connect classroom learning with societal needs and foster the development of scientifically informed citizens capable of evaluating complex problems.

Findings show that biology knowledge acquired at school can shape students' opinions toward socio-scientific issues. Students were more sceptical of GMOs and vaccinations, and less sceptical of evolution and climate change. Higher levels of biological knowledge reduced the likelihood of rejecting climate change and evolution. In contrast, no association was observed for attitudes toward vaccinations or GMOs, likely due to their limited coverage in standard curricula.

Providing high-quality biology education at all school levels is therefore essential. Teachers should actively monitor and address students' misconceptions, and ongoing professional development is crucial to maintain well-founded, scientifically grounded attitudes. In addition, since school is not the only source of information, students need to develop critical thinking skills and the ability to identify and use reliable sources.

Future research should examine additional factors influencing students' understanding, particularly the role of social media in spreading myths and conspiracy theories, as well as teachers' attitudes toward biological misconceptions. Students obtain information from diverse sources, but research often lacks a systematic assessment of how these sources interact with formal education.

Limitations related to sample representativeness include that the study was conducted in only four secondary schools and that different school types, as well as science- and non-science-oriented programs, were unevenly represented, which may limit the generalizability of findings. It is also important to acknowledge that studies like the present one often rely on self-report measures, which may underestimate or oversimplify the complexity of students' conceptual frameworks. Moreover, while the importance of biology in addressing societal challenges is emphasised,

current research may not fully account for sociocultural factors, such as values, beliefs, and trust in science, which shape students' engagement with scientific information.

Author Contributions

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Data Availability

The research data are available at Zenodo (https://doi.org/10.5281/zenodo.17822365).

Conflicts of Interest

The authors declare no conflict of interest.

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