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What do they know? Is Climate Change Education Necessary in Primary Schools in Serbia

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ABSTRACT

Climate change is a global crisis exacerbated by human activity and a matter of urgent concern. There is a significant knowledge gap among primary school students in Serbia, as the topic of climate change is barely covered in the curriculum. This study examines their awareness, knowledge and attitudes. Of the participants, 96.6% are aware of climate change, but their knowledge and attitudes vary considerably. Some 80.10% expect climate change to have a significant impact on humans through floods (90%), droughts and temperature increases (85% each). Further results show that schools are a key source of information (35.10%), followed by television (30.10%) and the internet (14.90%). In summary, this study highlights the need for comprehensive, multidisciplinary climate education to address different levels of awareness, encourage informed and proactive responses and engage young voices in discussions about climate change.

Introduction

Climate change is a formidable global challenge that has garnered increasing attention in recent years. Scientific consensus underscores the substantial impact of human activities on climate change, making it an undeniable and urgent concern (IPCC, 2021). This global phenomenon, fueled by anthropogenic factors, is already reshaping our world. Understanding the drivers, consequences, and potential solutions for climate change is of paramount importance on a global scale. Recent research reports have underscored the critical role of evaluating society's awareness and understanding of climate change, emphasizing the need for effective climate education (Khatibi et al., 2021; Mebane et al., 2023). Climate change education (CCE) has emerged as an integral component of environmental education within the broader context of sustainable development (Bangay & Blum, 2010; Keller et al., 2019). This educational framework plays a pivotal role in fostering eco-social competences and motivating individuals to embark on personal and collective efforts to mitigate the effects of climate change. The primary goals of CCE extend beyond imparting knowledge to encompass inspiring behavioral changes. Instilling this knowledge in young children is particularly vital, as it empowers them to grasp the human impact on the environment and comprehend the consequences of their actions (Baarova & Hibszer, 2022).

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Geography educators, in particular, bear the responsibility of shaping students' attitudes, beliefs, and pro-environmental behaviors. Geography, as an academic discipline, is uniquely positioned to impart knowledge on atmospheric processes, climate factors, climate zones, the causes and ramifications of climate change, and the regions experiencing the manifold environmental, social, and economic consequences of climate change, such as droughts, floods, and mass migrations. The rich curriculum content of geography education makes it the ideal subject for instilling an understanding of atmospheric phenomena and environmental transformations (Baarova & Hibszer, 2022; Enke & Budke, 2023). While prior environmental crises often had localized or regional impacts, climate change stands as a global threat. Its ramifications extend to threaten global civilization as a whole. In addressing and averting such universal challenges, education becomes the linchpin of the solution (Nepraš et al., 2022; Sund, 2016). Consequently, in the context of the issues arising from human-induced climate change, we turn our attention to CCE (Armstrong & Krasny, 2020; Tibola da Rocha et al., 2020). Well-executed CCE emerges as one of the most potent and enduring strategies for mitigation (Azevedo & Marques, 2017). So, climate change has transitioned from being merely an environmental issue to becoming an essential and dynamic educational and societal concern, where students actively participate (Karsgaard & Davidson, 2021). The profound impact of education on enhancing climate literacy, understanding and the ability to address the repercussions of global warming cannot be overemphasized. The United Nations Framework Convention on climate change has underlined the pivotal role of education in formulating a robust global response to climate change. In this context, it is imperative to scrutinize the role of climate change education in primary schools, as it lays the foundation for future generations' climate literacy and their active involvement in mitigating this global challenge. By analyzing geography textbooks from five different publishers in Serbia it can be noticed that not enough attention is dedicated to this important global problem. In Serbia, in official curriculum only 1 out of 134 lessons (0.75%) from 5th to 8th grade is dedicated to climate change and its consequences.

In Europe, the imperative to enhance science education, particularly in the realm of climate change, is increasingly recognized (Léna, 2009). However, significant challenges persist in the incorporation of high-quality, unbiased climate change content into school curricula (Uherek & Schüpbach, 2008). Public perceptions regarding climate change across Europe are shaped by diverse factors such as socioeconomic status, education levels, and the influence of prominent figures like Greta Thunberg (Baiardi et al., 2021). These insights underscore the criticality of effective CCE in Europe and the necessity for concerted actions to address this pressing issue. Recent research underscores the multifaceted influences on public attitudes toward climate change, emphasizing the need for coordinated efforts at the EU level, particularly in education and information dissemination (Baiardi et al., 2021). Efforts are underway to formulate a European educational framework encompassing environmental, nature, and climate protection, with an emphasis on hands-on learning and interdisciplinary approaches (Tomaszewska et al., 2018). The significance of CCE in Europe is emphasized as a cornerstone of a broader initiative for Education for Sustainable Development, aimed at deepening learners' comprehension and empowering them to take meaningful action (Mochizuki & Bryan, 2015). Practical implementation of climate change education is deemed essential, necessitating the expansion and coordination of diverse educational initiatives across all educational domains (Becker, 2018). Ultimately, education emerges as a pivotal tool in fostering the knowledge, skills, and values crucial for sustainability, including the comprehension, mitigation, and adaptation to climate change (Krasny & DuBois, 2019; Martin et al., 2007).

Research into CCE in several countries in Southeast Europe has revealed various approaches. In Greece, innovative strategies such as combining digital storytelling with traditional lectures have shown promise in enhancing students' knowledge and fostering behavioral change (Theodorou et al., 2019). Bulgaria emphasizes the need for a comprehensive and systematic approach to CCE, advocating for the establishment of a network of diverse educational activities (Becker, 2018). In Croatia, there is a recognized need for more extensive education on climate change, particularly focusing on its economic and tourism impacts (Šverko Grdinić et al., 2018), aligning with global efforts stressing the significance of local action and education in addressing climate change (Becker, 2018). Meanwhile, in Serbia, attention is drawn to the necessity of improving media coverage of climate change, especially within journalism programs (Vujović & Ilić Krstić, 2022). However, there remains a lack of specific information on climate change education in formal schooling, suggesting potential enhancements through integrating local ecosystem impacts and policy questions into teaching activities as proposed by Monroe et al. (2013).

This paper, therefore, explores the knowledge of primary school children in Vojvodina province (Serbia) about this important world issue. It elucidates the significance of CCE in shaping young minds, fostering environmental awareness, and preparing the next generation to effectively combat climate change. The study delves into the current state of CCE in primary schools and its implications for development eco-social competences, shaping attitudes, and catalyzing behaviors pertaining to climate change. By investigating the links between education and

climate change awareness. The aim of this research is to underscore the importance of effective CCE as a vital process for addressing and mitigating the impacts of climate change.

Data and methods

The central aim of this research was to determine the depth of primary school children's awareness concerning climate change and the repercussions it carries. Our initial premise revolved around the notion that climate change receives insufficient attention within the school curriculum, resulting in a lack of comprehensive information for children to grasp the full extent of its implications. This served as our primary hypothesis. Furthermore, our second hypothesis ventured to explore whether children's perspectives on climate change exhibited variations correlated with their age. Our study sought to investigate how these factors, including the curricular coverage of climate change, influenced the knowledge levels and attitudes of primary school children towards this pressing global issue.

Data collection

This study employed the field survey research approach, utilizing a questionnaire design specially for this study (Supplementary file). The data collection took place during the 2022/2023 school year and involved a random sample. After concluding the survey, a total of 632 fully completed questionnaires were obtained of which 17.1% were 11-year-old; 30.7% – 12-year-old; 28.5% – 13-year-oldand 22.7% – 14-year-old of which 296 (46.3%) were male and 336 (53.7%) were females. The respondents were diverse in terms of gender, age, educational institutions and residential locations (Table 1). The research was carried out in the Vojvodina province, situated in the northern region of the Republic of Serbia, encompassing both urban (62.7% of participants) and rural (37.3% of participants) settings (Fig.1). The participants willingly consented to take part in the study.

Table 1. Gender, age and residential locations of respondents

Grade	Total	Gender		Settlement type	
		Male	Female	City	Village
5th	106	60	46	31	75
6th	197	103	94	155	42
7th	184	83	101	119	65
8th	145	50	95	95	50

Research instruments

The research was conducted through an online survey. A two-part questionnaire was used in data collection. The

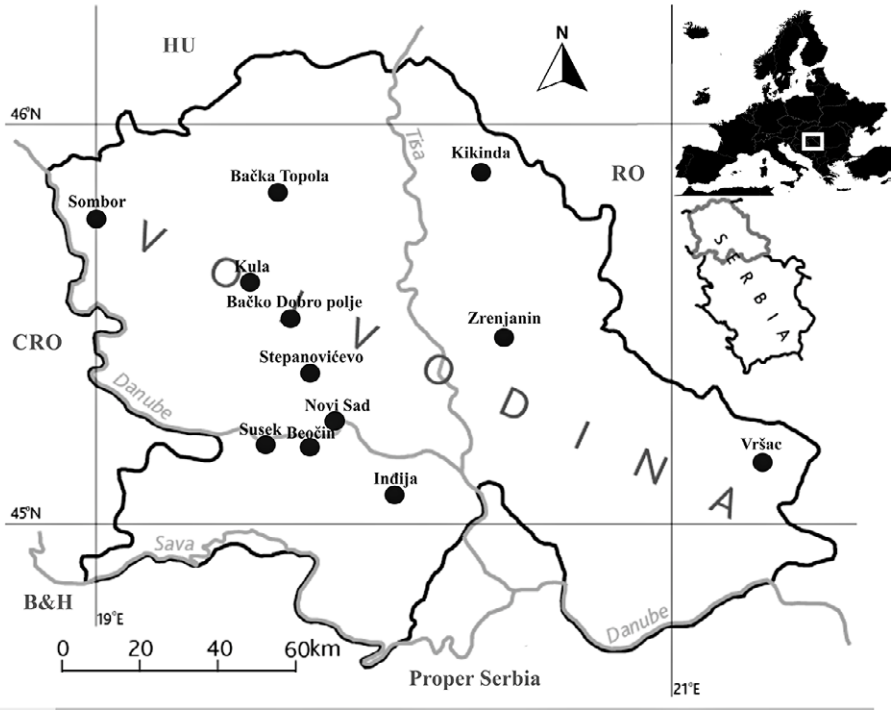

Figure 1. Geographical location of settlements where schools who participated in the study are located

first part collected mostly demographic data. Besides gender and grade, respondents were asked to write if the school that they live is in rural or urban settlement.

The second part of the questionnaire covered a range of essential inquiries related to climate change. Participants were asked about their views on the main cause of climate change, their self-assessment of climate change knowledge, and their preferred methods for educating themselves about this topic. They were also questioned about their exposure to climate change discussions in school and its potential impact on human lives. The survey delved into participants' interest in learning more about climate change, their perceptions of public awareness in Serbia, and their familiarity with specific consequences associated with climate change. Additionally, participants' beliefs in climate change, awareness of the Glasgow Climate Pact, and their willingness to further explore the consequences of climate change were queried. The questionnaire also sought to understand participants' views on the responsibility for addressing climate change issues, their conversations about climate change, and whether they believe young people should be actively engaged in climate crisis solutions. The survey concluded with questions about emotional responses to climate change, anticipation of future climate conditions, knowledge of the greenhouse effect and its primary cause, as well as preferences for self-education on the topic.

Data analysis

The data collected for this study were analyzed using the statistical software SPSS, version 20. Presented results were obtained according to different statistical analyses usually applied in similar researches: descriptive statistical analysis, ANOVA (one-way analysis of variance), including the determination of the significance of differences between specific groups conducted using the post hoc Scheffe test (Cvetković & Grbić, 2021; Karpudewan et al., 2015), these methods are appropriate for the research design as they enable the exploration of relationships between variables and facilitate the identification of significant patterns or trends within the dataset. The t-test analysis for independent samples was utilized to compare means between two groups, providing further insight into potential differences and associations (Cvetković & Grbić, 2021; Galway & Beery, 2022).

Significance of differences between particular groups can be established through the post hoc test, a technique designed to mitigate systematic errors that may arise from an increased number of comparisons between two arithmetic means. In this research, the Scheffe post hoc test, known for its stringent and frequent application, was employed (Agbangba et al., 2024). The sample fulfills basic conditions for parameter test application, i.e., data used in analysis originate from interval scale and they are normally distributed.

Results and discussion

ANOVA was used to define if there are statistically significant differences between dependent variables (school grade) and independent variable (several questions). Post-hock Scheffe test was applied to define significantly different variables.

Results show that 96.6% of participants have heard about Climate change, but the very next questions raise concern as 53.10% of participants consider that climate change is a consequence of natural climate cycles (Figure 2). Statistical analysis of participants answers shows significant differences at a level $p<0.05$ between 5th and 6th graders, where more 5th graders correctly stated that climate change is induced by human activity versus natural climate cycles that was most common answer among six graders ($F = 3.308$; $p = 0.047$). No statistically significant difference was observed among other grades. This result was expected as one lesson considering Climate change is located in 5th grade.

These results reveal an interesting division of opinions regarding the main cause of climate change. While a high percentage of students are aware of climate change, there are significant gaps in their understanding of its causes as 53.10 % attribute climate change to natural climate cycles,

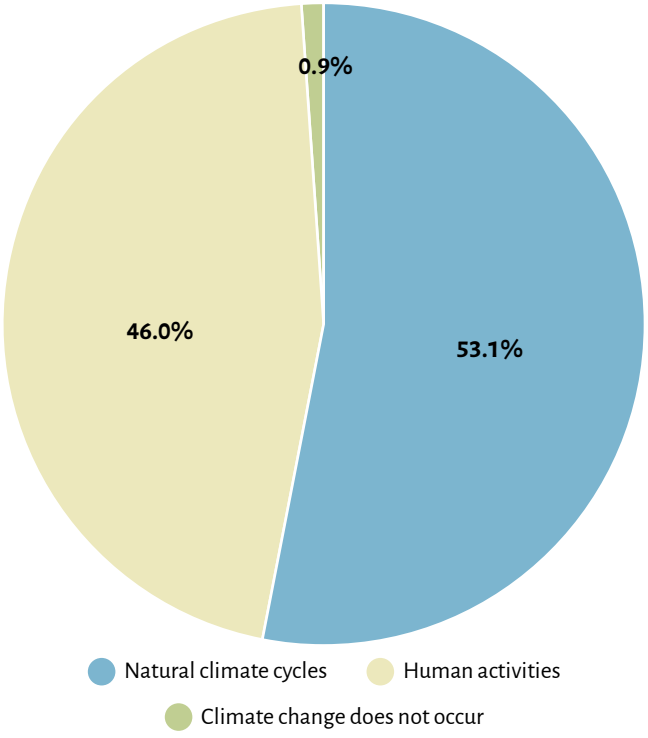

Figure 2. What is the main cause of climate change?

where 20.1% of 11-year-olds think this, 26.7% of 12-year-olds, 29.1% of 13-year-olds and 24% of 14-year-olds. Location of the school, did not show significant difference as 51.4% of answers were given by pupils that attend schools located in the cities and 48.6% attend schools in village. Similarly, research conducted in Spain has shown that pupils are aware of climate change, but lack overall understanding of climate change and the socio-economic consequences (Punter et al., 2011). Other research conducted in Study stated that only 13.6% of primary school children stated that human activities are the main cause of climate change. CCE study organized in South Africa have showed that while a high percentage of students were aware of climate change, many did not fully understand its causes and impacts (Kutywayo et al., 2022). This perspective suggests that a significant portion of the surveyed individuals may hold the belief that climate variations are primarily driven by natural factors, such as fluctuations in the Earth's climate system that have occurred throughout geological history.

On the other hand, 46% of the respondents attributed climate change to "Human Activities", specifically, 16.1% of the 11-year-olds, 32.7% of the 12-year-olds, 29.1% of the 13-year-olds, and 22.1% of the 14-year-olds identified human activities as the cause of climate change. In similar study conducted in Turkey, only about 25% of 11-12-year old participant, were aware of the causes of climate change (Akaygun & Adadan, 2021). Primary school students in Austria believe that climate change is mainly caused by humans and is happening now (Harker-Schuch et al., 2021). This viewpoint aligns with the widely accepted scientific consensus that human actions, particularly the emission of greenhouse gases, are the primary drivers of the observed changes in global climate patterns. It reflects the understanding that anthropogenic factors, such as the release of carbon dioxide and other greenhouse gases into the atmosphere, are significantly contributing to the current trends of global warming. Notably, a very small percentage, believed that "Climate change does not occur." This perspective contradicts the overwhelming scientific evidence that demonstrates the reality of climate change and its widespread impacts on ecosystems, weather patterns, and human societies. These findings emphasize the diverse range of opinions and beliefs about the causes of climate change among the survey participants. While there is ongoing scientific consensus on the role of human activities in driving climate change, it is clear that pupils' perceptions and understanding of this complex issue can significantly vary, potentially influenced by individual beliefs, education and exposure to information sources (Lekgeu & Davis, 2017; Levi, 2021; Nation & Feldman, 2021).

The results of the self-assessment of knowledge about climate change has revealed a range of findings (Fig. 3). A substantial portion, approximately 45.90%, expressed confidence in their understanding of climate change, suggesting a notable level of self-assuredness in their knowledge. On the other hand, a smaller percentage, 6.60%, considered their knowledge to be lacking or inadequate, highlighting a segment of the population that may require more information or education on the subject. Interestingly, a significant proportion, 41.90%, fell in the category of "Neither good nor bad," signifying a level of uncertainty or neutrality in their self-assessment. Additionally, a noteworthy percentage, 5.60%, admitted to not being sufficiently interested to seek out information about climate change, underscoring the importance of engagement and motivation in fostering awareness on this critical issue.

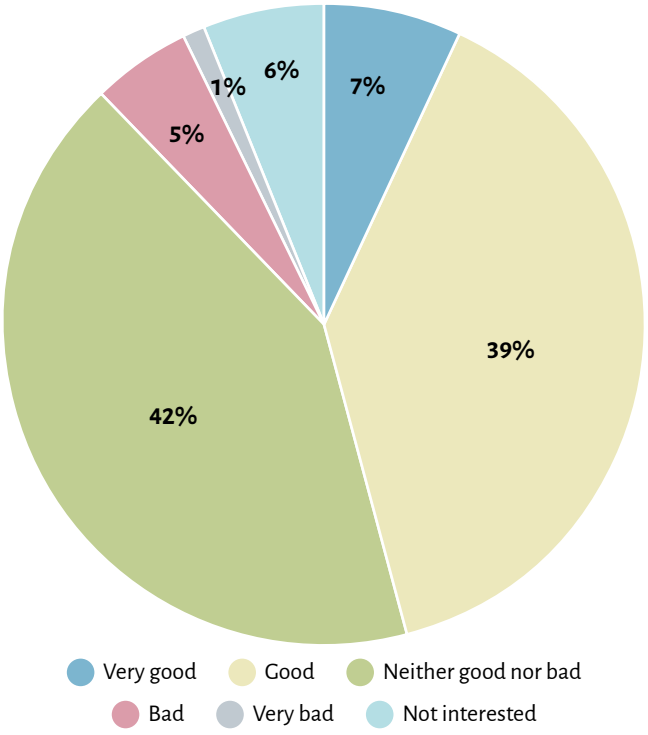

Figure 3. How would you assess your knowledge about climate change?

Results presented by Taber and Taylor (2009) and Karpudewan et al. (2015) also show that primary school students have a moderate level of awareness about climate change, with their knowledge and attitudes being positively influenced by hands-on activities and effective visual aids. However, there is a need for improvement in their knowledge, as a significant percentage of students still have misconceptions about the causes of climate change (Harker-Schuch & Bugge-Henriksen, 2013). In Slovenia for example, pupils in the 9th grade of primary school discuss the climate of their country through independent work, critical thinking, and the use of maps, pictorial material, and climatograms (Schauer, 2016). Overall, students generally feel confident in their ability to make a positive impact in relation to climate change (Taber & Tay-

lor, 2009). These results reveal a diverse range of perspectives on climate change knowledge, reflecting the need for tailored educational approaches to address varying levels of awareness and interest.

The data on how respondents educate themselves about climate change provide valuable insights into the sources of information and platforms they rely on (Fig. 4). It is notable that a substantial portion, 35.10%, turn to schools as their primary source of education on climate change, emphasizing the significance of formal education in shaping awareness. Television follows closely, with 30.10% of respondents utilizing it as a key medium for learning about climate change. The internet, including various websites and online resources, is also a prevalent source, with 14.90% of respondents utilizing this vast platform. Social media platforms, with 14.60%, play a role in disseminating information and engaging users in discussions related to climate change. Additionally, a smaller percentage, 5.30%, identified other methods not explicitly listed, indicating the diverse range of resources people use to educate themselves about climate change. A range of studies have explored the primary sources of information about climate change for European primary school students. Akaygun and Adadan (2021) have emphasize the importance of experiential and inquiry-based learning activities in fostering a deeper understanding of climate change. However, Özdem et al. (2014) highlighted the influence of media and education in shaping students' perceptions, suggesting a need for accurate information in these sources. Uherek and Schüpbach (2008) further underscored the challenge of integrating high-quality and impartial climate change material into the curriculum. These studies collectively underscore the need for a multi-faceted approach to climate change education, with a focus on accurate information, experiential learning, and the integration of high-quality resources into the curriculum.

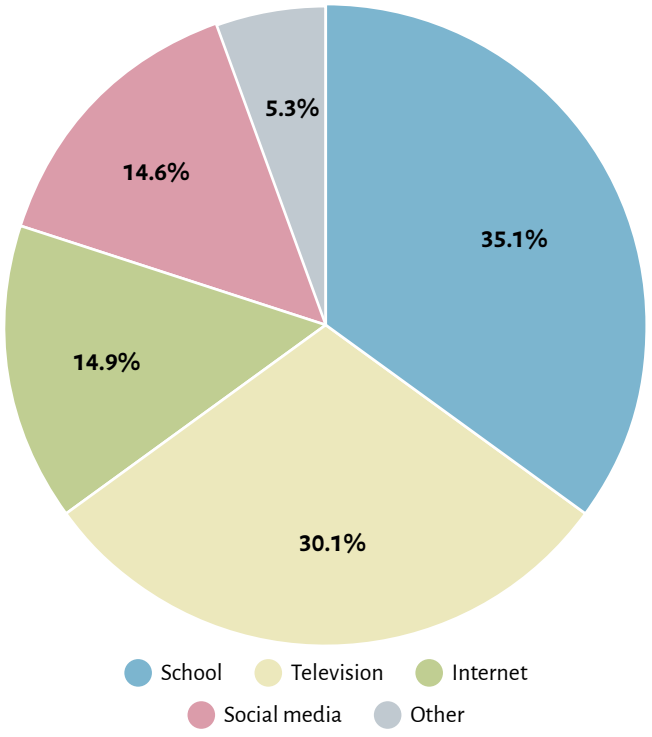

Figure 4. How do primary school students learn about climate change

Gender-related differences in gathering information regarding climate change topics were evident, with female students showing a tendency for receiving information through social media and teachers, while male students showed a tendency for television and teacher-based sources. The role of social media emerges as crucial in climate change education, facilitating information dissemination and fostering networks for knowledge exchange (Goritz et al., 2019; Robelia et al., 2011). Despite challenges such as state standards and divergent viewpoints, teachers remain integral to climate change education (Monroe et al., 2013). When compared results obtained with this study to the results reported for Valencia Region in Spain (Morote & Hernández, 2022), clear differences in between Vojvodina and Valencia Regions can be observed. In Vojvodina 30.10% of participants indicated that Television is their source of information about climate change while in Valencia 82.6% did the same. Study conducted in China reveal that most primary school children mainly get information about climate change from television and the internet (Wang et al., 2022). These findings underscore the importance of various channels and resources in disseminating knowledge about climate change, reflecting the need for a multi-faceted approach to public education and engagement on this critical issue.

The data regarding the school subjects where climate change and its consequences are discussed provide valuable insights into the curricular approach to this important topic. A significant majority, 48%, reported that they encounter discussions about climate change in their geography classes. This is in good accordance with results reported for Nigeria, where geography was highlighted as the most appropriate subject for learning about climate change (Onuoha et al., 2021). Several studies have shown that Geography is a crucial subject for teaching primary school children about climate change, as it provides a holistic understanding of the issue (Mitchell, 2023; Mwangu et al., 2017). Close behind, 46% of respondents mentioned biology as another subject where climate change is addressed. This dual emphasis on geography and biology highlights the multidisciplinary nature of climate change education, as it is explored through the lenses of both natural sciences and geography. Additionally, a smaller percentage, 6%, indicated that climate change discussions took place in subjects not specifically listed, indicating the potential for cross-disciplinary integration of climate change topics into the curriculum. A holistic approach

to climate change education is crucial, as it encompasses various subjects and fosters a comprehensive understanding of the issue (Snow & Snow, 2010). This approach should extend beyond the classroom, involving a coordinated and institutionalized effort of the education system (Szczepankiewicz et al., 2021). Interactive visualizations, multidisciplinary and iterative refinements can enhance students' understanding of climate change (Svihla & Linn, 2012).

The responses regarding the anticipated impact of climate change on humans highlight a widespread belief in the potential severity of this issue. A significant majority, approximately 80.10%, expressed the view that climate change will indeed have a substantial impact on humans. This strong consensus indicates a prevailing concern about the consequences of climate change and its potential to affect human societies. On the other hand, a smaller percentage, 14%, held the perspective that climate change will not have a significant impact on humans, reflecting a less pessimistic outlook. Additionally, 5.90% of respondents believed that the situation will remain unchanged, suggesting a degree of uncertainty or neutrality. These findings underscore the need for comprehensive measures to address the potential impacts of climate change and engage in proactive strategies to mitigate its effects. Deeper analysis reveals that there are clear gender differences, with a higher proportion of women (51.6%) expecting significant impacts compared to men (48.4%). The differences are greatest in the 12-year-old age group, with 30.7% anticipating a significant impact, compared to just 15.8% of 13 and 14-year-olds. Interestingly, women in both urban and rural areas express greater concern about the effects of climate change than men. However, significant differences can be observed between urban and village dwellers, particularly among women: 67.9% in urban areas expect significant impacts compared to 32.1% in rural areas. This indicates a possible influence of the place of residence on the perception of the effects of climate change.

The responses regarding the desire to learn more about climate change topics show a significant interest in further education on this critical issue. A substantial majority, around 66.50%, expressed a clear desire to learn more about climate change, indicating a strong motivation to deepen their understanding of the subject. Other studies also suggest that primary school children exhibit an interest in understanding climate change through child-centered activities that can enhance both their knowledge and positive attitudes toward the environment (Karpudewan et al., 2015; Tolppanen & Aksela, 2018). Conversely, 33.50% of respondents indicated that they do not wish to learn more about climate change. These results reveal a noteworthy segment of the pupils with a keen interest in expanding their knowledge and awareness about climate change, emphasizing the importance of providing accessible and engaging educational resources on this topic to cater to diverse preferences and interests. There are clear gender differences, with a higher percentage of female than male pupils expressing an interest in learning more about climate change. More specifically, 40.35% of female said they wanted to learn more, while only 33.54% of male expressed the same opinion. Among the age groups, 11-year-olds showed the least interest in learning more about climate change. Compared to the other age groups, only 13.92% expressed a desire to learn more. Conversely, the proportion of respondents who would like to learn more about climate change is highest among 12-year-olds at 22.31%. In terms of where they live, people who live in cities show a greater interest in learning more about climate change than people in villages. For example, 47.63% of urban respondents expressed a desire to learn more, while only 26.27% of rural respondents expressed the same opinion.

The opinions expressed regarding the awareness of the impact of climate change among the residents of Serbia reveal a diverse range of perspectives (Figure 5). A significant percentage of pupils, approximately 37%, believe that the residents of Serbia are indeed aware of the impact of climate change. Previously published results show that more than half of Serbian citizens (56.7%) are aware about climate change (Cvetković & Grbić, 2021). This suggests a considerable level of optimism about the level of awareness in the community. Conversely, 33.20% of respondents expressed the view that the residents of Serbia are not

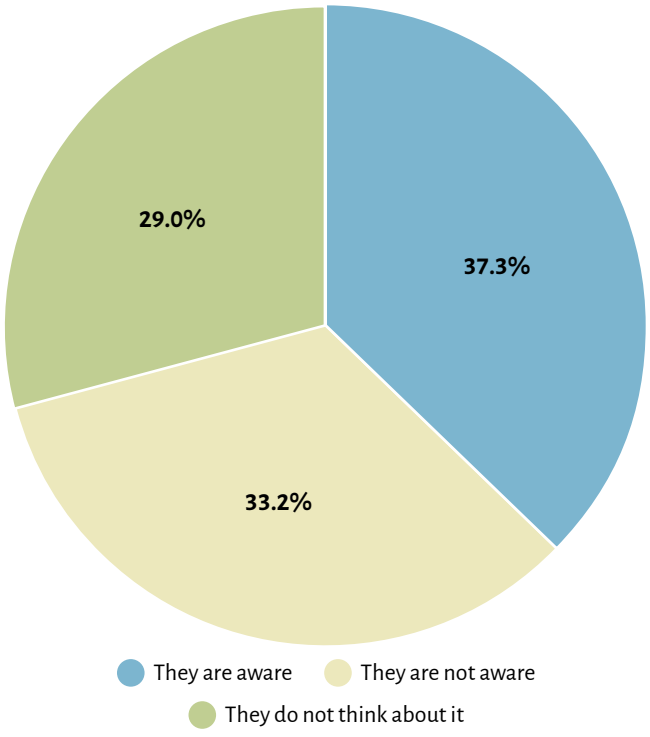

Figure 5. Pupils' Perceptions: Assessing Climate Change Awareness among Residents of Serbia

aware of the impact of climate change, indicating a sense of inadequacy in public knowledge and understanding. Additionally, 29.00% noted that people simply do not think about it, pointing to a segment of the population who may not have climate change on their mind. This result is considerably higher than results presented by Cvetković et al (2021) where only 14% of respondents stated that the issue of climate change is not important. Statistically significant difference was observed in answers between 5th and 8th graders, where younger pupils think that inhabitants of Serbia are aware of Climate change impact, while older pupils think that they are not aware ($F = 1.818$; $p = 0.17$). These varied responses emphasize the need for educational initiatives and awareness campaigns to ensure that all residents of Serbia are informed about the pressing issue of climate change and its potential consequences.

In Fig. 6, we can observe the responses regarding the consequences of climate change that participants have heard of. This was multiple choice questions where participants could select up to three consequences that were provided in the questioner. The for most causes that were the most recognized are floods (90%), droughts and temperature increase (85% respectively) and forest fires (80%). These findings reflect a broad and varied recognition of climate change impacts. Notably, a significant majority of participants reported awareness of key consequences, such as floods, droughts, temperature increases, forest fires, and rising sea levels. These high percentages signify a commendable level of public knowledge about these significant climate change-related effects. Moreover, the data reveals substantial awareness of other consequences, including declining river water levels, glacier melting, and changing precipitation patterns, although these topics gathered slightly lower recognition compared to the previously mentioned ones. However, it is noteworthy that ocean acidification was recognized by a smaller percentage of participants, indicating that this particular consequence may require more attention in climate education efforts. Generally, these findings collectively highlight the importance of comprehensive climate education to ensure that the pupils are well-informed about the full spectrum of climate change consequences, including those that may be less commonly known.

The responses to the question regarding the willingness to learn about the consequences of climate change demonstrate a relatively strong interest in acquiring more knowledge on this critical issue (Fig. 7). A significant majority, approximately 73.90%, expressed a clear desire to learn about the consequences of climate change, indicating a proactive approach to understanding and addressing this global challenge. Study conducted in 2015 reported that majority of pupils are willing and open to learn more about climate change in schools (Bello, 2015). Conversely, 26.10% of participants indicated that they are not interested in learning about these consequences, highlighting a segment of the population with limited motivation for further education on this topic. Again, statistically significant difference was observed between youngest and oldest students, where older ones stated that they are not interested in learning about climate change while younger once are more interested ($F = 0.697$; $p = 0.444$). These findings underscore the importance of tailored educational approaches to cater to varying levels of interest and knowledge, among pupils, regarding climate change consequences.

The responses regarding the perceived impact of climate change on one's future life reveal a mixture of opinions and levels of certainty (Fig. 8). A notable majority, approx-

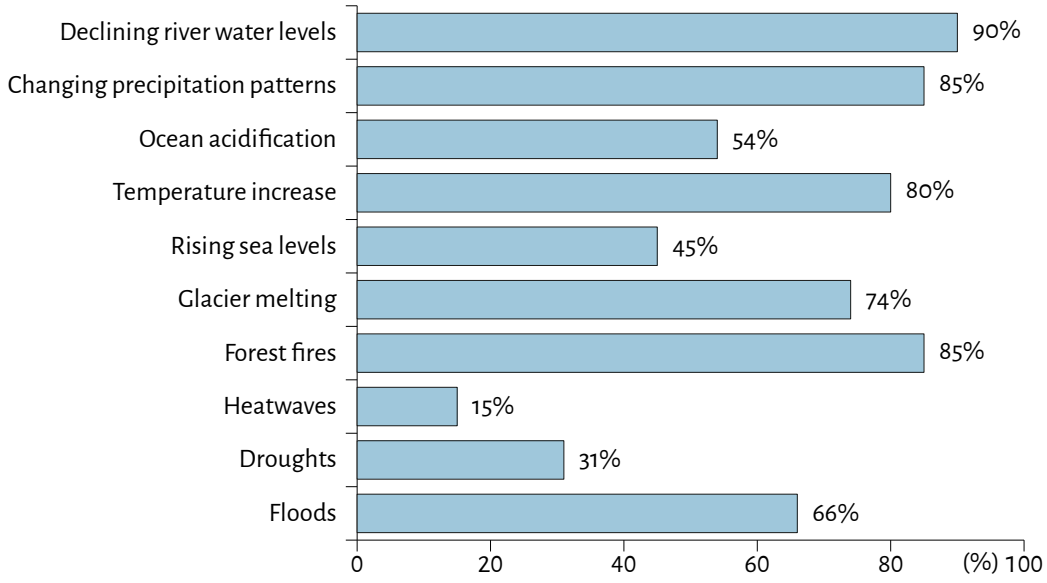

Figure 6. Pupils' opinions on the main consequences of climate change

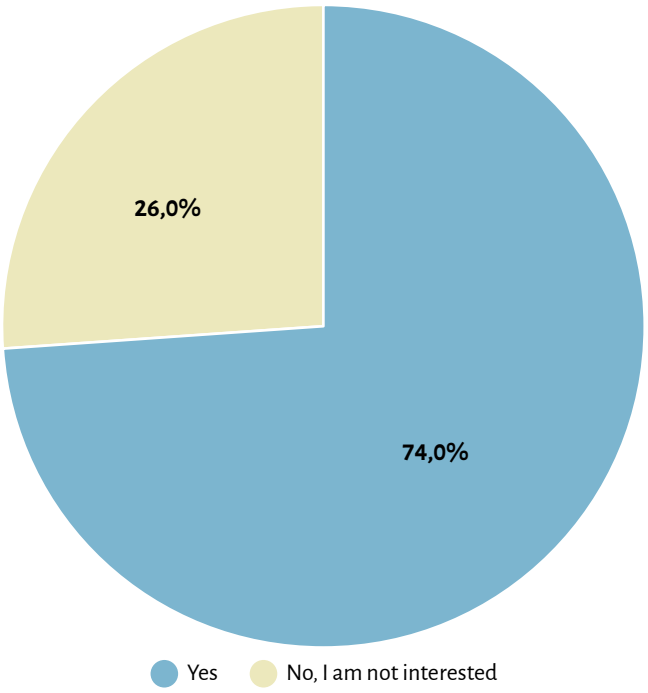

Figure 7. Pupils attitude towards learning about Climate change

imately 54.50%, believe that climate change will indeed affect their future life, underscoring a significant concern about the potential consequences of this global challenge. In contrast, a small percentage, 3.40%, do not anticipate any impact from climate change on their future. It is essential to note that a substantial portion, around 42%, expressed uncertainty by stating "I don't know," suggesting a lack of clarity or information regarding the future implications of climate change. Interesting is that answers again differ between 5th and 6th graders, even thou previously we showed that 5th graders better understand that climate change are induced by human activity, 6th graders show a better understanding of the influence that changing climate will have on their future. This difference is statistically significant at the level of 95% ($F = 1.812$; $p = 0.020$).

Findings presented in fig. 8 highlight the complex and varied perspectives on the personal ramifications of climate change, emphasizing the need for robust climate education and awareness initiatives to inform individuals about the potential impacts and foster proactive responses to this pressing issue.

Pupils' feelings about climate change are presented in fig. 9 encompass a range of emotions and attitudes. Participants reported a spectrum of emotions, including fear, confusion, worry, disinterest, interest, and curiosity. Climate change awareness is often accompanied by negative emotions, such as fear and frustration about the future (Rushton et al., 2023). However, there is potential to mitigate these feelings through education and awareness-raising activities, which have been previously shown to increase pupils knowledge about climate change and foster more positive environmental attitudes (Karpudewan et al., 2015). Additionally, a portion of respondents expressed other emotions or attitudes not explicitly listed, reflecting the diverse array of individual responses to the complex issue of climate change. Generally, young people in Europe

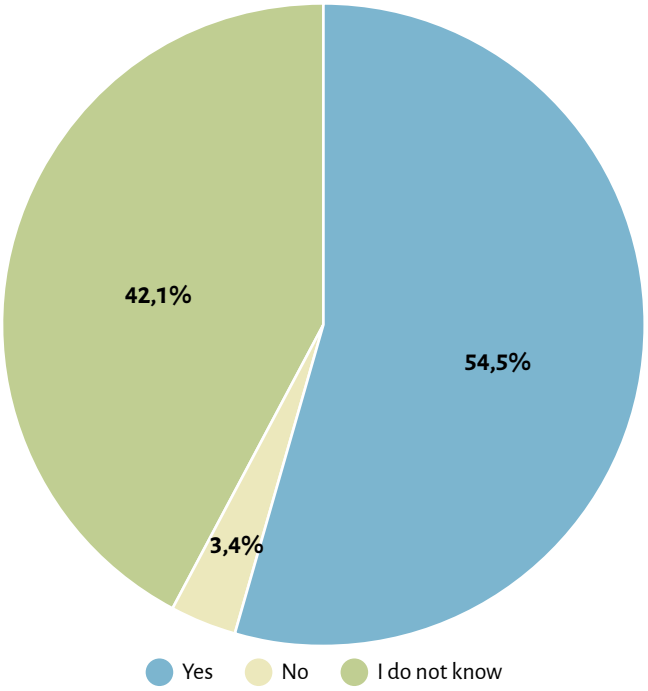

Figure 8. Pupils' opinions on whether climate change will influence their future

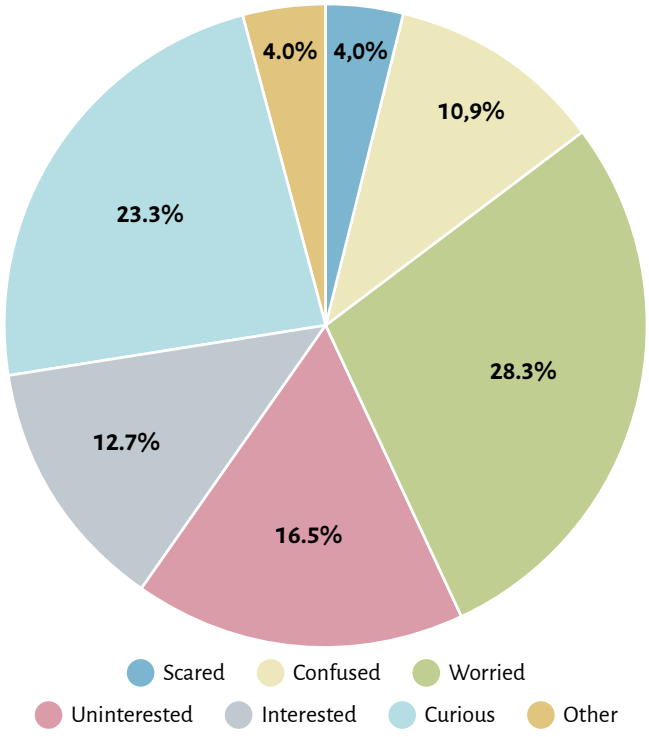

Figure 9. Pupils' sentiments regarding the consequences of climate change

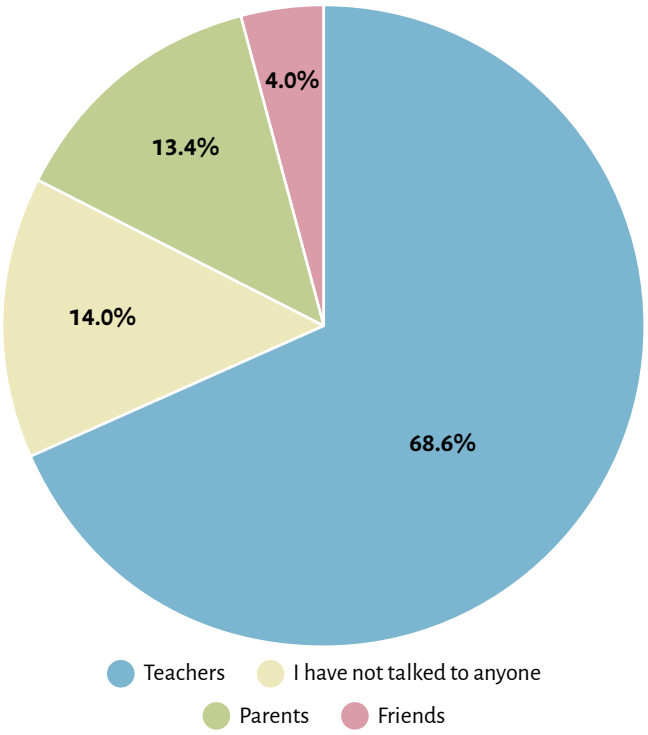

Figure 10. Pupils' responses regarding individuals with whom they have discussed the climate change

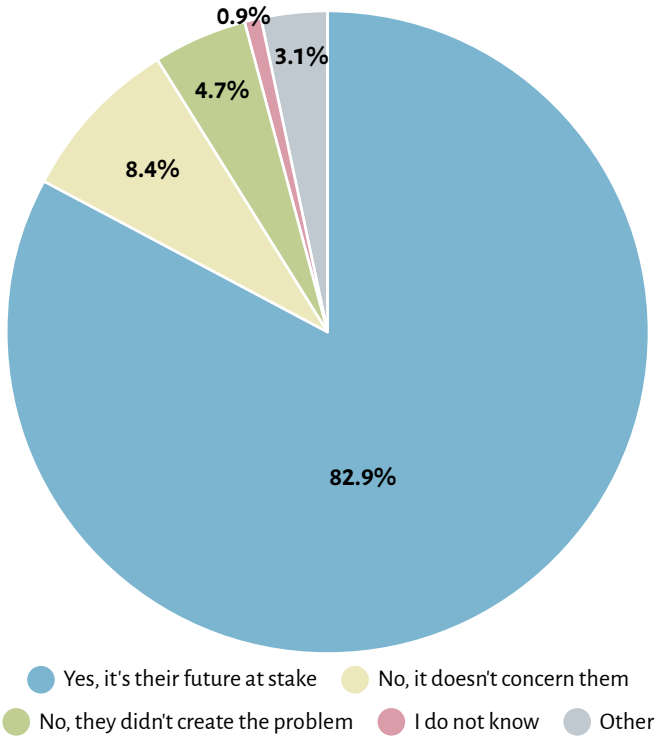

Figure 11. Pupils' opinions on whether young people should be involved in climate change actions

are less fatalistic about climate change, possibly showing the "meaning-focused coping" which enables that severity of climate change threat to be manageable (Smith & Leiserowitz, 2014). But negative feelings are still a prevalent theme of young people's perspectives about climate change (Corner et al., 2015). These findings highlight the need for comprehensive approaches to address both the knowledge gap and the varied emotional and psychological responses that individuals may have to climate change. Such inclusive strategies are crucial for effective climate communication and education.

The responses regarding individuals or groups with whom participants have discussed climate change indicate various sources of conversation and engagement on this topic (Fig. 10).

A significant majority, approximately 68.60% of the pupils reported having conversations with teachers, highlighting the role of educators in facilitating discussions and raising awareness about climate change. This is in good agreement with results reported in 2013 where teachers in primary school are highlighted as the primary source of information about climate change for primary school pupils (Ratinen et al., 2013). Conversely, 14% of pupils indicated that they haven't talked to anyone about climate change, emphasizing a need for increased dialogue and education on this issue. A smaller percentage, around 13.40%, mentioned parents as a source of conversation, suggesting the influence of family members in climate-related discussions. In comparison, 37.4% of primary schools students in Spain indicated family as their main source of information regarding climate change and only 44.5% stated that teacher are the main source of information (Morote & Hernández, 2022). Additionally, 4% of respondents cited friends as individuals with whom they have talked about climate change, indicating the role of peer interactions in fostering awareness. These results underscore the significance of educators and schools as key channels for climate communication, as well as the need for broader outreach and engagement efforts to reach those who have not yet had conversations about this critical global challenge.

The Fig. 11 presents responses to the question of whether young people should get involved in addressing the climate crisis. The data reveals a strong consensus, with approximately 82.90% of respondents advocating for young people's active participation in climate solutions. This coincides with results of the study conducted in Austria where more than 90% of primary school pupils believe that they must contribute to tackling climate change (Feldbacher et al., 2021). This reflects a widespread recognition that young individuals have a significant stake in the future impact of climate change.

Conversely, a smaller percentage, expressed the perspective that the climate crisis doesn't directly concern young people. Additionally, less than 5% of respondents indicated that young people should not be involved because they are not responsible for creating the problem. A very minor percentage, approximately 0.90%, reported

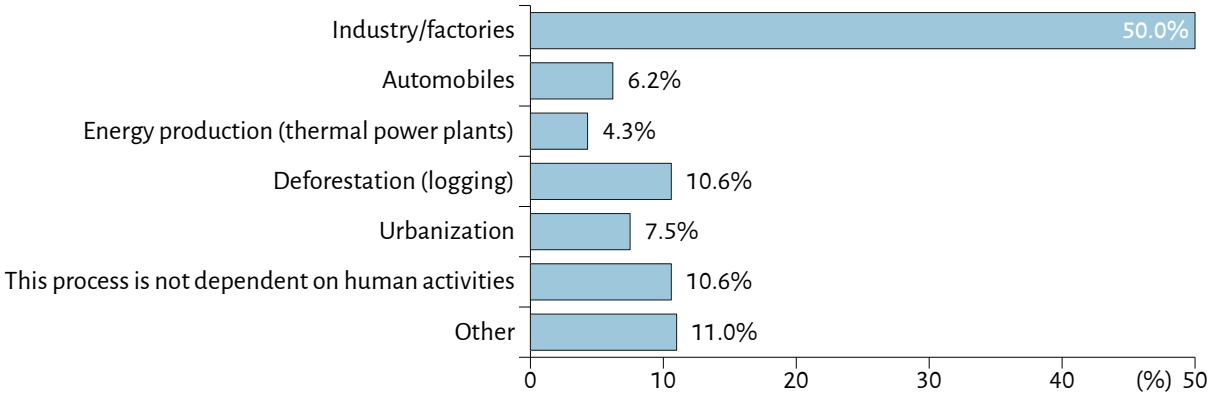

Figure 12. Pupils' opinions on the primary cause of climate change

not knowing whether young people should be engaged in climate solutions, highlighting a potential knowledge gap or uncertainty among this group. A further 3.10% selected "Other," which may encompass a range of nuanced opinions or alternative viewpoints on this matter. These findings emphasize the importance of including young voices in climate action discussions and suggest the need for continued efforts to foster youth engagement and understanding of their role in addressing the climate crisis (Campbell et al., 2013; Messiou, 2012).

The Fig. 12 presents responses to the question regarding the perceived main cause of climate change. The data reflects a variety of perspectives on this critical issue.

A significant percentage, approximately 50%, identified "Industry/factories" as the primary contributor to climate change, highlighting the role of industrial activities in influencing global climate patterns. A smaller percentage, around 6.20%, attributed climate change to "Automobiles," underscoring the impact of transportation emissions on the climate. Additionally, 4.30% pointed to "Energy production (thermal power plants)" as a significant factor in climate change. "Deforestation (logging)" was cited as a primary cause by approximately 10.60% of respondents, emphasizing the consequences of deforestation for climate stability. "Urbanization" was identified by 7.50% of participants, indicating the role of urban development in climate change. An interesting perspective emerges with 10.60% of respondents suggesting that climate change is not dependent on human activities, signaling a belief in natural factors contributing to climate variations. Furthermore, 11.00% chose "Other," indicating a diverse range of views and interpretations on the main cause of climate change. Majority of participants attributed the Climate Change and increase of the carbon dioxide atmosphere to automobiles and factories (Shepardson et al., 2009). In Spain, 70,1% of primary school children stated that pollution from factories is the main cause of Climate Change (Morote & Hernández, 2022). Gender differences are notable, with males attributing climate change more to automobiles (4.1%) compared to females (1.9%), while females attribute it more to industry (27.1%) compared to males (23.4%). Regarding age groups, variations exist in the perceived primary cause of climate change. For instance, industry is cited as the primary cause by 34.7% of respondents in cities compared to 15.8% in villages. Notably, there is a higher percentage of 14-year-olds in cities attributing climate change to urbanization (5.7%) compared to 14-year-olds in villages (1.9%). These findings suggest potential differences in environmental awareness and understanding among different demographic groups, underscoring the importance of tailored educational interventions to address misconceptions and promote a comprehensive understanding of climate change causality. These findings underscore the multifaceted nature of climate change causality and the need for comprehensive approaches to address the various contributing factors and their interconnectedness.

The responses to the question regarding awareness of the Glasgow Climate Pact show a substantial disparity in familiarity with this significant international climate accord. An overwhelming majority of respondents, approximately 90.40%, indicated that they have not heard of the Glasgow Climate Pact. In contrast, a notably smaller percentage, around 9.60%, are aware of this agreement. These results reflect the need for more extensive public outreach and education to ensure that people are informed about and engaged with critical global climate initiatives like the Glasgow Climate Pact, which play a vital role in addressing climate change challenges.

The involvement of young people in addressing the climate crisis is a critical issue, with significant potential for impact. Dunlop et al., (2021) and Sanson and Bellemo (2021) have highlight the role of schools and teachers in nurturing and responding to climate activism, with a focus on overcoming barriers and supporting young people's capacity for action. Narksompong and Limjirakan (2015) have emphasized the need for national policies to adequately educate and engage youth in climate change

issues, while Van Den Hazel (2019) underscores the importance of youth as key actors in raising awareness and promoting sustainable practices. The responses regarding the perceived responsibility for addressing the issues that cause or result from climate change reflect a diversity of viewpoints (Fig. 13). A small percentage, approximately 1.90%, believe that the individual ("Me") holds this responsibility. A slightly larger percentage, around 4.70%, view youth as having a role in addressing climate change. Additionally, a minority of respondents, 2.20%, see politicians as responsible, while 24.85% attribute this responsibility to the government. A substantial portion, about 13.40%, places the onus on the international community, while 22.70% look to scientists to address climate change challenges. A noteworthy 24% believe that society as a whole share this responsibility. Furthermore, 6.05% cited other entities or factors not explicitly listed as responsible for addressing climate change issues. Several studies have explored the attitudes and knowledge of secondary school students towards climate change. Abd Hamid et al. (2021) as well have reported that while students were aware of climate change but this did not necessarily translate into action. Similarly, Holmqvist Olander & Olander (2017) noted that students had a general understanding of climate change as a system, but did not often consider their individual contributions. These diverse perspectives underline the complex web of actors and institutions involved in climate change mitigation and adaptation. Addressing this global challenge requires collective effort and cooperation among a wide range of stakeholders, as well as public engagement and awareness to facilitate effective climate action.

The t-test for independent samples compares the mean values between two different groups for the same continuous, dependent variable. Examining the responses of male and female students on climate change revealed nuanced and statistically significant differences in their perceptions and attitudes. Unique patterns emerged on several aspects that included the projected impact of climate change on people, awareness of residents of Serbia, emotional reactions to future climate conditions, communication dynamics about climate change, the role of young people in addressing the climate crisis, and preferences for learning about climate change issues. Notably, there was a significant gender gap in people's perceptions of the impact of climate change. The t-test results showed a mean difference of $t_{(95)} = -0.141$; $p = 0.038$, indicating different views on the severity of the consequences of climate change, with male students expressing greater concern. This is in contrast to the results of the global study reported in 2023 where it is stated that female primary school students are expressing greater concern and negative emotions about climate change, while male respondents are more optimistic (Clayton et al., 2023). There was also a notable gender difference in opinions about awareness of the effects of climate change among residents of Serbia, with a significant mean difference of $t_{(95)} = -0.178$; $p = 0.010$. This emphasizes the difference in views, especially the perception of male students, that the population of Serbia is insufficiently aware of climate change. Female students have expressed greater preference to learn about climate change, with a mean difference of $t_{(95)} = 0.064$; $p < 0.001$. This highlights the difference in levels of interest and curiosity, with female students expressing a greater desire to learn more about climate change. These findings highlight the importance of considering gender perspectives in climate change awareness initiatives, education campaigns and policy formulation. Tailoring communication strategies to address these divergent viewpoints can contribute to a more inclusive and effective approach in promoting climate change literacy and engagement.

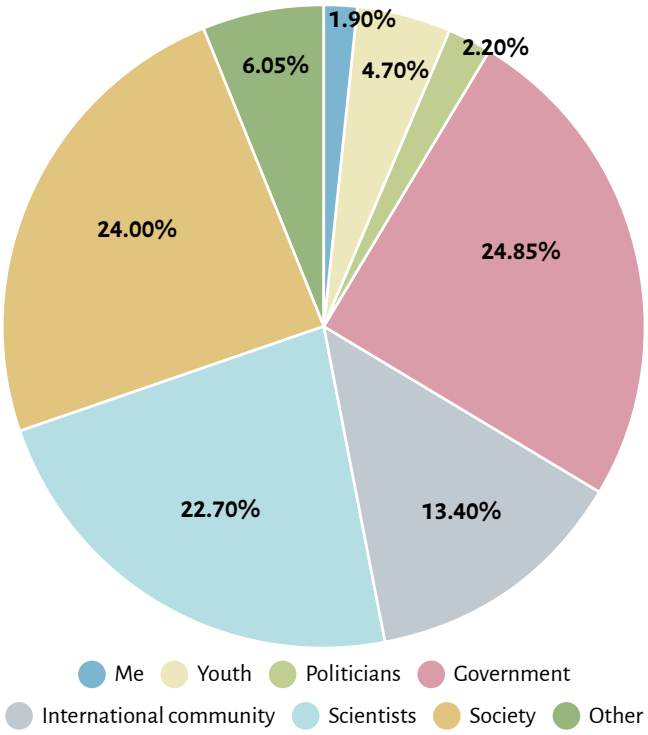

Figure 13. Pupils' opinions on who should address the issue of climate change

Conclusion

The comprehensive examination of primary school children's knowledge, attitudes, and perceptions regarding climate change has yielded valuable insights and observations. The results reveal a diverse landscape of awareness among the participants. While a significant majority have heard about climate change, a noteworthy proportion holds misconceptions, attributing it to natural climate cycles. This highlights the importance of targeted educational efforts aimed at providing accurate information about the drivers of climate change to young individuals. Participants' self-assessment of their climate change knowledge indicates a wide range of confidence levels. While many express confidences, some acknowledge knowledge gaps or a lack of interest. This diversity underscores the need for tailored educational approaches that cater to varying levels of awareness and motivation for climate change awareness. The study identifies schools as the primary source of climate change knowledge, followed closely by television and the internet. This emphasizes the pivotal role of formal education in shaping young minds and fostering awareness. However, the prevalence of alternative resources like social media highlights the need for diversified approaches to disseminate climate information effectively. The multidisciplinary approach to climate change education, primarily through geography and biology classes, underscores the need for a holistic understanding of this complex issue across various subjects. The strong consensus among participants regarding the potential severity of climate change's impact on humans indicates a prevailing concern. This underscores the importance of comprehensive measures and proactive strategies to mitigate climate change effects. The desire of a majority of participants to learn more about climate change topics emphasizes the need for accessible and engaging educational resources catering to diverse preferences and interests. Opinions about the awareness of climate change's impact among the residents of Serbia vary, underlining the importance of educational initiatives and awareness campaigns to inform the public about the issue and its potential consequences. While there is broad recognition of various climate change-related impacts, some consequences have lower recognition levels, particularly ocean acidification, suggesting a need for more focused attention in climate education efforts. The willingness to learn about climate change consequences is strong, but a segment expresses disinterest or a lack of motivation, highlighting the importance of tailored educational approaches for different individuals. The diverse perspectives on the potential impact of climate change on one's future life underline the need for robust climate education and awareness initiatives to inform individuals and foster proactive responses. The broad range of emotional and psychological responses to climate change emphasizes the need for inclusive strategies to address the knowledge gap and diverse reactions to this complex global challenge.

In conclusion, this study underscores the need for targeted climate education efforts, diversified information sources, and comprehensive, multidisciplinary approaches to address varying levels of awareness and interest among primary school children in Northern Serbia. Furthermore, it highlights the importance of encouraging young voices in climate action discussions and fostering informed and proactive responses to the pressing issue of climate change.

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Supplementary file: Survey created and used for this study

Climate Change Awareness Survey

1. Gender
   [] Female
   [] Male

2. Grade
   [] 5
   [] 6
   [] 7
   [] 8

3. Name the locality where your school is located (Not the school's name, just the name of the town/city).
   _____

4. Have you heard about climate change?
   [] Yes
   [] No

5. What is the main cause of climate change?
   [] Natural climate cycles
   [] Human activities
   [] Climate change does not occur

6. How would you assess your knowledge about climate change?
   [] Very good
   [] Good
   [] Neither good nor bad
   [] Bad
   [] Very bad
   [] I am not interested enough to educate myself

7. How do you educate yourself about climate change?
   [] Social media
   [] School
   [] Television
   [] Newspapers
   [] Websites on the internet

8. Which school subject have you discussed climate change and its consequences in? (Open-ended)
   [] Geography
   [] Biology
   [] Chemistry
   [] Physic
   [] Other: _____

9. Do you think climate change will have a significant impact on humanity?
   [] Significant impact
   [] Will not have an impact
   [] Nothing will change

10. Would you like to learn more about climate change?
    [] Yes
    [] No

11. In your opinion, are the residents of Serbia aware of the impact of climate change?
    [] They are aware
    [] They are not aware
    [] They do not think about it

12. What consequences of climate change have you heard of? (Multiple answers possible)
    [] Floods
    [] Droughts
    [] Heatwaves
    [] Forest fires
    [] Glacier melting
    [] Sea level rise
    [] Temperature rise
    [] Ocean acidification
    [] Changes in precipitation patterns
    [] Decrease in water levels in rivers and lakes

13. Would you like to know more about climate change and its consequences?
    [] Yes
    [] No

14. In your opinion, will climate change affect your future life?
    [] Yes
    [] No
    [] I don't know

15. How do you feel when it comes to climate change? Are you:
    [] Scared
    [] Confused
    [] Worried
    [] Uninterested
    [] Interested
    [] Curious
    [] Other: _____

16. With whom have you discussed climate change?
    [] With friends
    [] With teachers
    [] With parents
    [] I have not discussed it with anyone

17. Should young people get involved in solving the climate crisis?
    [] Yes, it's their future at stake
    [] No, it's not their concern
    [] No, they did not create the problem
    [] I don't know
    [] Other: _____

18. In your opinion, what is the main cause of climate change? (Choose three answers)
    [] Industry/factories

[] Automobiles
[] Energy production (thermal power plants)
[] Deforestation
[] Urbanization
[] This process does not depend on human activities
[] Other: _____

19. Have you heard of the climate agreement from Glasgow?
[] Yes
[] No

20. In your opinion, who is responsible for addressing the problems resulting from climate change?
[] Me
[] Young people
[] Politicians
[] Government
[] International communities
[] Scientists
[] Society
[] Other: _____