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MISCONCEPTIONS AMONG PRIMARY SCHOOL TEACHERS – THE CONTRIBUTION OF SOCIODEMOGRAPHIC FACTORS

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Abstract/Izvleček

With the aim of examining the contribution of sociodemographic factors to differences in the recognition of misconceptions, the Misconceptions of Teachers in Science questionnaire was developed. This study addresses two main objectives: evaluating the reliability of the newly designed questionnaire and examining the influence of sociodemographic factors on the identification of scientific misconceptions among elementary school teachers. The results indicate that the questionnaire exhibits satisfactory reliability. A statistically significant difference in the recognition of misconceptions was found based on gender and place of employment.

Keywords:
identification of misconceptions, science teaching, sociodemographic factors, questionnaire *Misconceptions of Teachers in Science*.

Znanstvene zmote med učitelji osnovnih šol – prispevek socialno-demografskih dejavnikov

Z namenom preučiti vpliv **socialno-demografskih** dejavnikov na razlike pri prepoznavanju napačnih predstav je bil razvit vprašalnik o napačnih predstavah učiteljev v naravoslovju. Študija obravnava dva glavna cilja: oceno zanesljivosti novo zasnovanega vprašalnika in preučitev vpliva **socialno-demografskih** dejavnikov na prepoznavanje napačnih znanstvenih predstav med učitelji v osnovni šoli. Rezultati kažejo, da vprašalnik daje zadovoljivo zanesljivost. Ugotovljena je bila statistično pomembna razlika v prepoznavanju napačnih predstav glede na spol in kraj zaposlitve.

Ključne besede:
prepoznavanje napačnih predstav, poučevanje naravoslovja, sociodemografski dejavniki, vprašalnik *Zmote učiteljev v naravoslovju*.

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Introduction

During their years of schooling, students encounter various natural science concepts, many of which they have already encountered and formed opinions about (Pine, Messer and St. John, 2001), whether correct or incorrect. As students attempt to assimilate new information into their existing knowledge structures, the results can include undesirable teaching outcomes (Talanquer, 2006). Misconceptions are obstacles to learning science (Malaterre, Javaux and López-García, 2023), students' ideas based on experience or informal education, which are not well structured (Soeharto et al., 2019) and are not in accordance with scientific knowledge (Mestre, 2001; Bahar, 2003; Soeharto et al., 2019). Furthermore, misconceptions are misunderstandings arising from the connection between new and old concepts that are already present in students' minds (Suprapto, 2020); these arise when children try to explain in their own way the phenomena and processes they observe (Lukša, 2011). Misconceptions are characterized by the fact that they are widespread and resistant to change because they make sense to the individuals who created them (Fisher, 1985; Dikmenli et al., 2009; Soeharto et al., 2019).

Misconceptions are not a phenomenon that occurs in children alone, adults, including teachers, lecturers and professors, can also have them (Suprapto, 2020). Teachers who have misconceptions can become the main cause of student misconceptions (Desstya et al., 2019; Furlan and Fošnarič, 2014), which is precisely the emphasis of this paper. The quality of teacher education is closely related to students' educational achievements (Jurić, 2007; Bayuni, Sopandi, and Sujana, 2018). Hashweh (1987) states that teachers sometimes have the same misconceptions as their students. Many of these misconceptions appear in their lesson planning and teaching practices and result in reinforcement of student misconceptions rather than their correction with scientific facts. Given the rapid development of science and technology, and because the meaning attributed to concepts is changing and evolving, conceptual learning is of the utmost importance (Kiray et al., 2015).

Previous research into misconceptions

To determine the misconceptions of elementary school teachers in the field of natural sciences, the most commonly used instruments are interviews, open-ended questions, multiple-choice questions and multi-level tests (Gurel, Eryilmaz, and McDermott, 2015; Soeharto et al., 2019; Juliani, Yusrizal, and Huda, 2021), while

Bahar (2003) also suggests the use of word association, diagnostic trees, conceptual maps, etc. According to these authors, each instrument has its advantages and disadvantages, and therefore the combination of several methods is better than the use of a single method.

Research on misconceptions among elementary school teachers in the field of natural science, with a special emphasis on sociodemographic factors, is crucial for understanding educational challenges in this area. Identifying teachers' misconceptions allows us to determine which scientific concepts teachers may not understand or may misinterpret, which can negatively affect students, who are often susceptible to learning incorrect information. Since teachers may transmit their own unconscious misconceptions, it is important to identify which sociodemographic factors (such as gender, age, years of teaching experience, and place of employment) influence teachers' ability to recognize their own misconceptions.

Several research projects have been conducted in Croatia with the aim of detecting misconceptions: these focused on elementary and high school students as well as students in specific study areas, while research on misconceptions among elementary school teachers is lacking. Research conducted by Letina (2019) can be highlighted with the aim of considering science literacy among teachers in the field of natural science and its importance for science education. The results demonstrated that the students showed the greatest lack of understanding regarding the following statements: "*The sun revolves around the Earth*;" "*Antibiotics kill viruses*;" "*Oil is denser than water*;" "*Vaccination is the injection of drugs against certain diseases*;" and "*A 'heavier' body falls faster than a 'lighter' body*." These five statements were also adopted for the questionnaire used in the current research.

Previous research, such as that conducted by Treagust (1988) and by Arslan, Cigdemoglu, and Moseley (2012), suggests that gender may play a significant role in the ability of teachers or students to recognize misconceptions. For instance, Treagust (1988) highlights how gender can influence the types of misconceptions that develop among teachers and students. Furthermore, research in various contexts indicates that teachers with more experience do not necessarily have a better understanding of scientific concepts, while younger teachers or teachers with specific educational experiences may have a fresher approach to learning and to recognizing misconceptions. Research by Soeharto and Csapó (2022) shows that gender can influence how students understand scientific concepts; it can therefore be assumed that teachers of different genders may have different approaches to recognizing misconceptions.

The assumption that men are better at recognizing misconceptions than women is based on earlier research suggesting that there is a significant difference in scientific ability between the genders, which may affect the recognition of misconceptions (Treagust, 1988). Also, the expectation of significant differences in recognizing misconceptions based on years of teaching experience, age, and place of residence stems from the finding that educational programs and professional development, which allow teachers to gain a deeper understanding of scientific concepts, may equalize teachers regardless of these factors. Research by Liampa et al. (2017) shows that educational tools, such as three-tier diagnostic tests, can reduce differences in the ability to recognize misconceptions among teachers of different ages and experience. The importance of this research is reflected in the insufficient operationalization of and research into the misconceptions of elementary school teachers, since they are the potential source of student misconceptions. Detecting the areas of natural science in which elementary school teachers show a certain number of problems and misconceptions could enable the restructuring of existing curricula and development of quality teacher education programs. Therefore, the information provided by the results of this research could be very significant. The hypotheses in this research allow the exploration of the extent to which sociodemographic factors, such as gender and years of teaching experience, influence the ability of elementary school teachers to identify misconceptions.

Aim, problem and hypotheses

The aim of this research is to examine the presence of misconceptions among elementary school teachers in the field of natural science and to analyse the impact of sociodemographic factors on recognition of these misconceptions. Considering the objectives of the research, two key issues were addressed. The first issue involves examining the reliability of *The Misconceptions of Teachers in Science* questionnaire, which was developed to detect teachers' misconceptions. The second issue focuses on analysing the impact of sociodemographic factors, such as gender, years of teaching experience, teacher age and place of residence on the recognition of misconceptions in the field of science. Teachers who have misconceptions can be a major cause of student misconceptions (Desstya, 2019; Pine, Messer, and St. John, 2001), as they are the ones who formally introduce science concepts to students for the first time. Therefore, the purpose of this paper is to uncover areas in which elementary school

teachers show weaknesses in order to influence educational policy change. Discovering key characteristics that influence the possession and recognition of misconceptions is of utmost importance to be able to influence them in a timely manner. Based on these issues, five hypotheses were formulated:

H1 - The first hypothesis predicts that *The Misconceptions of Teachers in Science* questionnaire will demonstrate satisfactory reliability (McDonald's omega of .60 or higher), which would allow for its application with potential future improvements.

H2 - The second hypothesis expects that gender differences will be observed in the recognition of misconceptions among teachers, with men being better at recognizing misconceptions than women.

H3 - The third hypothesis predicts that there will be significant differences in recognizing misconceptions based on place of employment, with teachers from urban areas being better at recognizing misconceptions than those from rural areas.

H4 – The fourth hypothesis predicts that there will be significant differences in recognizing misconceptions based on years of teaching experience, with teachers who have more teaching experience being better at recognizing misconceptions than those with less teaching experience.

H5 – The fifth hypothesis predicts that there will be significant differences in recognizing misconceptions based on teachers' age, with older teachers being better at recognizing misconceptions than younger ones.

Hypotheses H3 – H5 examine key factors that may influence teachers' ability to recognize misconceptions, which is important for improving the quality of science education.

Method

Participants

The research included 162 elementary school teachers. Most participants were female, while a smaller percentage were male. The participants were from different age groups and had varying levels of work experience, which provides a representative sample for this population. The largest group of participants was in the 40 to 49 age range, while the smallest group was in the 60 and older category. In terms of place of employment, 72.84% of the participants worked in cities, while 26.67% worked in rural areas. The teachers had diverse levels of teaching experience, with the majority having between 20 and 30 years, while the smallest number of participants had

between one and two years of teaching experience. This diversity makes the results applicable to a broader population of elementary school teachers.

Table 1
Demographic characteristics of participants

Variable	Category	N	%
Gender	Male	29	17.90
	Female	133	82.10
Age	29 years and younger	34	20.99
	30-39 years old	42	25.93
	40-49 years	43	26.54
	50-59 years	31	19.14
	60 or older	12	7.41
Place of employment	City	118	72.84
	Village	44	27.16
Years of teaching experience	0-1 years	11	6.79
	1-2 years	9	5.56
	2-5 years	35	21.61
	5-10 years	15	9.2
	10-20 years	35	21.61
	20-30 years	37	22.84
	Over 30 years	20	12.35

Instruments

Before completing the *Misconceptions of Teachers in Science* questionnaire, sociodemographic data were examined: gender, age, years of teaching experience and place of employment (city or village).

The *Misconceptions of Teachers in Science* questionnaire examined the prevalence of misconceptions in the field of natural science among elementary school teachers. The task of the questionnaire for the population of elementary school teachers in Croatia is to discover which concepts and terms in the field of natural science are unclear to teachers, or for which teaching content they show conceptual misunderstanding.

The questionnaire consists of 37 questions. Twenty-five of these were taken from the original questionnaire created by Grbeša (2019), and the remaining twelve were added for the purpose of additional examination of areas of interest in this research, especially in the field of chemistry and physics within natural science. The sources for the remaining twelve questions are as follows: Letina (2019) for questions 4, 8, 15, 16, 29; Lekić and Mance (2023) for questions 6 and 9; Lukša et al. (2013) for questions 18, 21, 30; Babić (2018) for question 31, modified for the purposes of this research.

In the study conducted by Grbeša (2019), 183 students from the Teacher Education Department of the Faculty of Humanities and Social Sciences in Split participated. They answered 25 questions by selecting T if they thought the statement was true, or N if they thought the statement was false. After each question, the students determined their level of confidence in the answers (1-3-5). On average, students answered 5 out of 25 questions in the survey incorrectly, or exhibited misconceptions. The author (2019) claims that students would have answered several statements correctly if they did not have misconceptions. Most misconceptions occurred in the areas of plants, chemistry, and physics. Also, the students were quite confident in their answers, which confirms the existence of misconceptions.

The *Misconceptions of Teachers in Science* questionnaire was intended to include areas of natural science related to the teaching content of students in the lower grades of elementary school, i.e. from 1st to 4th grade of elementary school (nature, humans, the cell, physics, chemistry, plants, animals, and nature protection). The questions examined whether teachers knew the concepts they taught students, i.e. in areas identified as posing a problem for elementary school teachers.

During the survey, participants had to answer questions consisting of various misconceptions, where each question had a correct and incorrect answer. The total score was the sum of correct answers to all questions, and a higher score indicated a higher level of knowledge, i.e. a lower prevalence of misconceptions.

Procedure

The research was conducted in such a way that teachers filled out an online questionnaire, i.e. a questionnaire created in Google Forms format. Many participants were recruited by participating in professional meetings of elementary school teachers, where teachers accessed the *Misconceptions of Teachers in Science* questionnaire by scanning a QR code. The remaining participants were recruited by sharing the questionnaire link on the Facebook social network. At the beginning of the questionnaire, brief instructions were provided explaining the nature and purpose of the questionnaire, ensuring anonymity and confidentiality of the data, and emphasizing that participants could withdraw from completing the questionnaire at any time. Consent to participate in the research was obtained before volunteers answered the questionnaire. Completing the questionnaire took approximately 10 minutes.

Data Analysis

The data were analysed using both descriptive and inferential statistics. Descriptive statistics included the calculation of frequencies and percentages of participants' responses to individual questionnaire items.

Inferential statistical analyses were conducted to examine differences between groups of participants. An independent samples t-test was used to compare differences between two groups, using Welch's t-test to compare differences in recognizing misconceptions by gender, and Student's t-test to compare differences in recognizing misconceptions based on place of employment. One-way analysis of variance (ANOVA) was applied when comparing differences in recognizing misconceptions based on the teaching experience and age of teachers. These analyses were used to explore differences in participants' recognition of misconceptions depending on their characteristics (e.g., years of teaching experience, level of education, or other sociodemographic variables). The level of statistical significance was set at $p < .05$. Data were analysed using SPSS.

Ethical Considerations

Ethical approval was obtained for the research. Participants were fully informed about the purpose, procedures, and voluntary nature of the study. Each respondent provided informed consent, and they were assured that their participation was entirely voluntary and that they could withdraw at any time without penalty or consequence. To protect the privacy of respondents, confidentiality and anonymity were maintained throughout the study. No identifying information was collected, and responses were used solely for academic purposes. The data collected were securely stored and accessible only to the researchers.

Results

Descriptive Statistics

To analyse the data collected in this research, descriptive statistics for the *Misconceptions of Teachers in Science* questionnaire were performed to obtain basic indicators of the result distribution. Table 2 presents the basic descriptive statistics for the questionnaire.

Table 2
Descriptive statistics for the questionnaire Misconceptions of Teachers in Science

N	TR	AR	M	SD
162	0-37	13-32	25.086	3.845

Note: M = arithmetic mean, SD = standard deviation, TR = theoretical range, AR = achieved range

The results show that the total scores on the questionnaire ranged from 13 to 32 points, with a mean value of 25.086 and a standard deviation of 3.845. These indicators suggest a relatively narrow distribution of scores with moderate variability.

Hypothesis 1

The first hypothesis (H1) predicted that the *Misconceptions of Teachers in Science* questionnaire would show satisfactory reliability, with a McDonald's omega value of .60 or higher, which would allow its application with further improvements. To test the reliability of the questionnaire, two McDonald's omega (ω) values were calculated – one before and one after the removal of items that showed a negative correlation with the overall score. The results presented in Table 3 indicate an improvement in reliability after revision of the questionnaire.

Table 3
Reliability of the Misconceptions of Teachers in Science questionnaire

Questionnaire version	ω	LL 95% CI	UL 95% CI
Before removing items	0.61	0.548	0.678
After removing items	0.73	0.664	0.785

Note: ω – McDonald's omega reliability coefficient, LL 95% CI - lower limit of the confidence interval, UL 95% CI - upper limit of the confidence interval

The first reliability assessment showed that McDonald's omega was slightly above the acceptable limit (.60), indicating the potential for improving the instrument. After elimination of items that negatively affected internal consistency, the omega value increased to 0.73, resulting in a more stable and reliable measure. These results confirm H1 and indicate the validity of further application and adaptation of the questionnaire.

Hypothesis 2

The second hypothesis (H2) predicted that men would recognize misconceptions better than women. To test this hypothesis, Welch's t-test was conducted because the basic prerequisites for using the Student's t-test were not met (equality of variances via Levene's test: $F=4.59$, $df=1$, $p<.05$). The results presented in Table 4 indicate a significant difference between genders in recognizing misconceptions.

Table 4

Differences in recognizing misconceptions by gender (Welch's t-test)

Gender	N	M	SD	t	df	p	Cohen's d
Male	29	28.31	2.83	6.39	51.01	< .01	1.20
Female	133	24.38	3.68				

Note: N = number of participants, M = arithmetic mean; SD = standard deviation, t = t ratio, df = degrees of freedom, p = significance level

The results show that men were significantly better at recognizing misconceptions than women. The value of Cohen's d (1.196) indicates a large effect, suggesting a significant difference between the groups and confirming hypothesis H2.

Hypothesis 3

The third hypothesis (H3) predicted that there would be significant differences in recognizing misconceptions based on place of employment. To test this hypothesis, Student's t-test was conducted, and the results are given in Table 5.

Table 5

Differences in recognizing misconceptions based on place of employment (Student's t-test)

Place of employment	N	M	SD	t	df	p	Cohen's d
City	118	25.49	3.80	2.22	160	< .05	.40
Village	44	24.00	3.82				

The results of Student's t-test showed a statistically significant difference in recognizing misconceptions among teachers based on place of employment, with teachers from urban areas being better at recognizing misconceptions than those from rural areas.

The value of Cohen's d (0.40) indicates a modest but meaningful difference between the groups, supporting hypothesis H3 and highlighting the importance of place of employment as a sociodemographic factor in understanding misconceptions.

Hypotheses 4 and 5

The fourth hypothesis (H4) predicted that there would be significant differences in recognizing misconceptions based on years of teaching experience; the fifth hypothesis (H5) predicted that there would be significant differences in recognizing misconceptions based on teacher age. To test these two hypotheses, one-way analysis of variance (ANOVA) was conducted.

Table 6

Differences in recognizing misconceptions based on teaching experience and teacher age (ANOVA)

Variable	F	df	p
Years of teaching experience	1.40	6.155	>.05
Age of the teacher	1.94	4.157	>.05

Note: F = F-ratio, df = degrees of freedom, p = significance level

The results of the ANOVA analysis showed no differences in recognizing misconceptions based on years of teaching experience and age of the teachers (Table 6).

Discussion

The aim of this study was to examine the presence of misconceptions among elementary school teachers in the field of science and to analyse the impact of sociodemographic factors on recognizing these misconceptions. The study showed that elementary school teachers do possess significant misconceptions related to basic scientific concepts such as gravity, energy, chemical reactions, and biological processes. These results confirm the findings of previous studies (Bayuni, Sopandi, and Sujana, 2018; Gurel, Eryilmaz, and McDermott, 2015), which suggest that teachers often have incorrect ideas about fundamental scientific concepts.

The research confirmed the first hypothesis (H1), since the McDonald omega coefficient was .72, indicating a high reliability of the instrument. This result aligns with previous research confirming that high reliability in diagnosing misconceptions among teachers is crucial for their further application (Arslan, Cigdemoglu, and

Moseley, 2012). The questionnaire showed that teachers can recognize basic misconceptions that frequently occur in students' understanding of scientific concepts, but the research also suggests that further improvement of the instrument could enable more precise identification and specific strategies for correcting these misconceptions.

The second hypothesis (H2) was also confirmed. The results of this study suggest possible differences in recognizing misconceptions, namely that men are better at recognizing misconceptions than women. Based on the findings, specific pedagogical approaches and learning styles that men apply in teaching were identified. The literature often emphasizes that men in the education system tend to use more direct and systematic approaches to learning, while women are more likely to use a holistic approach. Such an approach may result in different abilities in recognizing and correcting student misconceptions. Research has also shown that male teachers more often use quantitative approaches and diagnostic methods, which may enable better identification of specific areas where students make mistakes (Chen et al., 2020; Pine, Messer, and St. John, 2001). Male teachers may have a greater tendency to apply more traditional methods, such as tests and diagnostic tests, which allows them to identify and analyse misconceptions based on specific student responses. Somewhat contrary to these results, Han, Kang, and Noh (2010) found that preservice teachers who held less traditional conceptions of teaching and learning were better at predicting common student misconceptions, without specifying teachers' gender.

Furthermore, male teachers tend to react less emotionally to student mistakes, which enables a more objective approach to identifying conceptual mistakes (Shtulman and Walker, 2020). Women may be more likely to interpret student responses emotionally, while men may approach the analysis with a greater emphasis on technical aspects, such as accuracy and structure of responses (Golubić, Begić, and Radanović, 2019). Another study (Halim et al., 2025), which discusses the experience of remediating misconceptions among science teachers, states that there is a significant correlation, positive and high, between understanding of TPACK and the experience of correcting misconceptions among male teachers, while the correlation is relatively low among female teachers.

More specifically, Anim-Eduful, Aboagye, and Baah-Yanney (2025) find differences in the understanding of integrated scientific concepts in balancing chemical equations, where female participants performed significantly better than males. Furthermore, there is some research (Sansone, 2019; Thomas, 2017) suggesting that teacher

gender and teacher stereotypes can influence students' motivation and academic attitudes.

It is obvious that the results are not clear, simple and comprehensive. The results of this study are valid for this small population of teachers in Croatia, and given the low proportion of men among participants, they cannot be generalized.

The third hypothesis (H3) predicted that there would be significant differences in recognizing misconceptions based on the place of employment. This hypothesis was confirmed. The results showed that teachers from urban areas (cities) recognize misconceptions better compared to teachers from rural areas. This finding aligns with the literature suggesting that teachers in urban environments have better access to professional resources, educational tools, and new technologies, which can significantly improve their ability to identify and correct misconceptions (Bayuni, Sopandi, and Sujana, 2018). In urban areas, teachers often have greater opportunities to participate in professional development programs, which allows them to continuously improve their pedagogical skills, including the recognition of student misconceptions (Soeharto and Csapó, 2022). The research also shows that teachers from rural areas may have less access to such resources, which could limit their ability to identify and correct misconceptions in student learning (Lukša et al., 2013).

Because the number of teachers working in rural areas and those working in urban areas is not approximately equal, these results also need to be viewed in the context in which they were created, i.e. they correspond to the number of teachers working in urban and rural areas in Croatia.

In our sample, no significant differences were observed in recognizing misconceptions relative to the age and teaching experience of teachers, so hypotheses H4, that predicted that there would be significant differences based on teaching experience, and H5, that predicted that there would be significant differences based on teacher age, are not accepted. Although it was expected that older and more experienced teachers would be better at recognizing misconceptions, the results show that years of teaching experience and teacher age did not have a significant impact on recognizing misconceptions. Research by Blanuša Trošelj, Peić Papak, and Zuljan (2021) about teachers' Science and Technics competences and professional development showed that teachers with fewer years of experience feel a lower level of professionalism than those with more years of experience. This lack of self-confidence can lead to reduced science competence, or the competence to recognize misconceptions.

Teaching experience alone may not be enough for teachers to better recognize student misconceptions. More important factors could include the continuous education and training of teachers. Research shows that professional development and education can be key factors, along with many others, that enable teachers to better identify and correct misconceptions, even if they lack years of teaching experience (Deshmukh and Deshmukh, 2007; Sadler et al., 2013; Lukša 2013b). Self-reflection, as a prerequisite for constructivist teaching, along with professional development, is crucial for teachers (Škugor, Tomaš, and Letina, 2025).

Based on these findings, it can be assumed that teachers' long-term teaching experience is related to their general understanding of educational processes, but specific training on misconceptions and science topics makes a significant difference in their ability to recognize and correct misconceptions in learning.

Our results are consistent with some from previous research, but not all. The multitude of conflicting results points to the complexity of the phenomenon, which needs to be further investigated in the future.

Several limitations were observed during the implementation of the research that can be highlighted. Primarily, there is a small proportion of male respondents, which indicates that the sample of respondents is not representative with respect to gender, i.e., it reduces the generalizability of results. The main shortcoming of the study is the insufficient research on misconceptions in the field of science that occur among elementary school teachers, i.e. the lack of available literature to refer to in this case. Given the breadth of the field of science, it is difficult to single out questions that best examine certain science concepts. Previous research had included a specific group of respondents, such as students in specific programs, in certain areas of science, such as physics (Guerra-Reyes et al., 2024), chemistry (Abenes, Caballes, 2020), biology (Mawaddah, Ibrahim, and Suparaptio, 2020), or more specifically, in optics, photosynthesis, ovulation, etc. A comprehensive questionnaire that would specifically test elementary school teachers on a wide range of science concepts was not found, and the current questionnaire was created by combining the research previously mentioned in the paper, and in accordance with the teaching content offered in the lower grades of elementary school. The disadvantage of testing misconceptions through a questionnaire with possible answers True and False is that it does not provide insight into the teachers' understanding of the concepts, but the aim of this research is only to identify areas that pose a problem for teachers, and these form the basis for further research.

An additional limitation of this study relates to the development and validation of the *Misconceptions of Teachers in Science* questionnaire. Although the instrument demonstrated satisfactory internal consistency, as indicated by the McDonald's omega coefficient, this represents only a preliminary indicator of its psychometric quality. The study did not include exploratory or confirmatory factor analysis, which would be necessary to examine the underlying structure of the questionnaire and provide stronger evidence of construct validity. Furthermore, the instrument was constructed by combining items from previously used questionnaires with newly developed items, which may have affected its structural coherence. Therefore, the questionnaire should be considered exploratory in nature and primarily suitable for identifying general areas of misconceptions rather than providing a fully validated measurement of a single construct. Future research should focus on conducting comprehensive validation procedures, including factor analysis and additional tests of validity, to establish a more robust and theoretically grounded instrument.

For future research, it is recommended to supplement and use a larger number of items, which could potentially affect the structure of the questionnaire and its psychometric characteristics. Also, it is desirable to divide the variables of teacher's age and years of work experience into only three categories, since the categories in the current study may be unnecessarily broad.

Conclusion

The conclusion of this research provides significant insights into teachers' ability to identify misconceptions in science and the impact of sociodemographic factors on these abilities. The results confirmed that the *Misconceptions of Teachers in Science* questionnaire shows satisfactory reliability, enabling its use in further research and educational practice. Additionally, the research found that men are better at recognizing misconceptions compared to women. Teachers from urban areas also showed better ability to identify misconceptions compared to those from rural areas.

This research highlights the importance of continuous professional development for teachers, not only in terms of pedagogical methods, but also in developing their ability to recognize and correct student misconceptions. Further research could focus on a deeper understanding of specific factors that influence teachers' abilities to identify misconceptions, as well as on developing new tools and methods for their diagnosis and correction.

Ultimately, the results of this research can serve as a basis for the development of educational policies and practices that will enable teachers to better identify and correct misconceptions in science teaching, thereby contributing to improved educational quality and better student understanding of key scientific concepts.

Data Availability Statement

The article is based on data fully presented and discussed within the article itself; therefore, no additional data archiving is required.

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The final version of the Misconceptions of teachers in natural science questionnaire

	Statement	T / F
1	Natural science is the collective name for chemistry, physics and biology, which study living things, life processes and the laws on which life is based	T / F
2	Sustainable development teaches us about the responsible use of natural resources	T / F
3	The Sun revolves around the Earth	T / F
4	A nanometre is a unit of measurement for length	T / F
5	Clean water conducts electricity	T / F
6	"Heavier" things fall faster than "lighter" things	T / F
7	Rabies is a viral disease that only affects animals	T / F
8	HIV is a disease caused by the AIDS virus, and is transmitted mainly through sexual intercourse, infected blood (needle, transfusion) and can be transmitted from mother to child during pregnancy	T / F
9	Vaccination is the injection of drugs against certain diseases	T / F
10	Antibiotics kill viruses	T / F
11	The sex of the child is determined by the mother	T / F
12	The ovaries are organs that make up the male reproductive system	T / F
13	Carbohydrates are the slowest to break down in the body	T / F
14	Proteins are made up of amino acids	T / F

15	Every living being consists of a certain percentage of water	T / F
16	Carbon dioxide is a product of cellular respiration	T / F
17	Dmitri Ivanovich Mendeleev created the first periodic table of elements	T / F
18	Photosynthesis is a chemical process by which, in organisms that have chlorophyll, with the help of sunlight, glucose and oxygen are created from water and CO2	T / F
19	A neutral solution is formed by mixing acids and bases	T / F
20	Oil has a higher density than water	T / F
21	A plant takes nutrients from the soil	T / F
22	Plants use oxygen for photosynthesis	T / F
23	A fruit develops from a plant's seed	T / F
24	Homeothermic animals cannot maintain a constant body temperature	T / F
25	The greenhouse effect is the phenomenon caused by the action of C02 and other harmful gases, which retain heat in the atmosphere	T / F
26	Ozone is a gas that protects us from UV radiation	T / F
27	Acid rain is dangerous only for forests	T / F

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