education sciences

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Exploring Croatian In-Service Primary Teachers' Professional Attitudes Toward Science Using the Dimensions of Attitude Toward Science (DAS)

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Abstract: Teachers holding positive professional attitudes towards science is a key prerequisite for high-quality teaching and consequently for the sustainability of ongoing science education reform, which is being implemented in Croatia for the first time. Therefore, this cross-sectional study examined the attitudes, views, and self-reported behaviour of primary school teachers in the context of science teaching. The sample included 950 teachers during the 2024/2025 school year. Data were collected using the DAS questionnaire and analyzed using descriptive and inferential statistical methods. Most teachers expressed positive professional attitudes toward science teaching and held, broadly defined, a contemporary view of science. However, the frequency of implementing science-specific teaching activities remained relatively low. Correlational analyses revealed a moderate positive association between attitudes and behaviour ($r = 0.396$, $p < 0.001$), and a weak but statistically significant association between attitudes and views of science ($\rho = 0.081$, $p = 0.012$). The results indicate the need for systematic support in teacher education and professional development, particularly in strengthening teachers' competencies required for conducting science-related activities. This study contributes to a deeper understanding of teachers' professional orientations within the context of Croatia's current educational reform and provides a foundation for aligning national practice with European evidence-based educational policies.

Keywords: STEM; science; primary education; in-service teachers; DAS instrument

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Academic Editors: Thomas Roberts, Stefanie Livers and Holly Plank

Received: 8 April 2025
Revised: 23 May 2025
Accepted: 30 May 2025
Published: 3 June 2025

Citation: Erceg, N., & Ivošević, T. (2025). Exploring Croatian In-Service Primary Teachers' Professional Attitudes Toward Science Using the Dimensions of Attitude Toward Science (DAS). *Education Sciences*, *15*(6), 692. https://doi.org/10.3390/educsci15060692

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1. Introduction

The phenomenon known as the "swing away from science" has captured the attention of the research community since the 1960s, yet it remains a concern in many countries (J. Osborne et al., 2003). Despite growing global awareness of the importance and economic value of science knowledge, the number of young people choosing an educational or career path in this field remains low (House of Lords, 2000; Jenkins, 1994; Lepkowska, 1996; J. Osborne et al., 2003; S. I. Van Aalderen-Smeets et al., 2017), and scientific illiteracy among the general population is becoming increasingly widespread (Durant et al., 1989; J. D. Miller et al., 1997). In an effort to reverse these negative trends, science education researchers are placing increasing importance on teachers' attitudes toward science and science teaching (Bleicher, 2007; Haney et al., 1996; Johnston & Ahtee, 2006; Wendt & Rockinson-Szapkiw, 2018). They argue that positive attitudes are a key prerequisite for high-quality teaching (Asma et al., 2011; Clark & Peterson, 1986; Haney et al., 1996; Johnston & Ahtee, 2006;

Sessah Mensah & Walker, 2020; Tobin & McRobbie, 1996; Van Driel et al., 2001; Walma Van Der Molen & Van Aalderen-Smeets, 2013), and consequently, for the sustainability of educational reforms in which teachers play an important role (Ajzen & Fishbein, 1980; Crawley & Koballa, 1992; Cuban, 1979; Duffee & Aikenhead, 1992; Fullan & Miles, 1992; Van Driel et al., 2001). This claim is supported by the findings of Haney et al. (Haney et al., 1996) and Czerniak and Lumpe (C. M. Czerniak & Lumpe, 1996), who found that teachers' attitudes toward implementing reform-based science teaching methods were the strongest predictors of their intentions to do so.

As in other countries, interest in studying and pursuing professional development in the field of science in Croatia has been steadily declining, particularly when it comes to teacher education programmes (Erceg et al., 2022, 2023). With the aim of promoting science education, an experimental curriculum for the subject *Science* is currently being implemented in the lower grades (1st to 6th grade) of selected primary schools (Erceg & Alajbeg, 2024; Ministarstvo znanosti, obrazovanja i mladih RH [Ministry of Science and Education of Croatia], 2023b). This has been taking place since the 2023/24 school year as part of the four-year Experimental Program "Elementary School as a Whole-Day School: A Balanced, Fair, Efficient, and Sustainable System of Education". In this programme, Science is described as a subject based on the understanding of fundamental natural sciences, including physics, chemistry, biology, physical geography, and geology, with the primary goal of developing scientific literacy (Ministarstvo znanosti, obrazovanja i mladih RH [Ministry of Science and Education of Croatia], 2023a). This is the first programme of its kind in Croatia, and it may soon lead to the introduction of Science as a separate and compulsory subject in all Croatian primary schools.

Since teachers' attitudes are key factors in educational reforms aimed at effective science education (Haney et al., 1996; Johnston & Ahtee, 2006; McDonald et al., 2021), including the aforementioned Croatian reform, we decided to conduct a study—the first of its kind in Croatia. Due to the relatively small number of people affected by the reform (Erceg & Alajbeg, 2024), the entire population of primary school teachers was included in the sample. The results of this study can serve as guidelines for promoting positive attitudes through teacher education programmes and professional development for science educators, with the aim of supporting the sustainability of the ongoing reform.

In addition to its applied goals, this study is grounded in a theoretical perspective that recognizes teacher attitudes, epistemological views, and classroom behaviour as interrelated constructs. Drawing on the multidimensional model (Walma Van Der Molen & Van Aalderen-Smeets, 2013), attitudes toward science teaching are understood as comprising cognitive beliefs, affective states, and perceived control. These dimensions can influence whether teachers adopt more constructivist, inquiry-based approaches or rely on transmission-oriented, teacher-centred instruction. By examining how these constructs interact in the context of an educational reform, this study also aims to contribute to theory-building in science education.

The DAS instrument was selected, not only for its alignment with this framework but also for its cross-cultural applicability (Wendt & Rockinson-Szapkiw, 2018), making it a suitable tool for capturing the complexity of teachers' professional orientations in the Croatian context. This is particularly important given that the attitudes of Croatian primary school teachers have not yet been investigated within the framework of the Teaching and Learning International Survey (TALIS), as Croatia does not participate in the additional survey module intended for primary school teachers (ISCED 1—Primary Education). The scientific contribution of this study, based on a sample of Croatian teachers, is also reflected in confirming the applicability of the DAS questionnaire for measuring attitudes across different cultural contexts.

2. Theoretical Framework and Literature Review

Attitudes and their influence on behaviour have been the subject of research for many years. This is evidenced by the fact that as early as 1975, Fishbein and Ajzen (Fishbein & Ajzen, 1975) developed the Theory of Reasoned Action, which posits the existence of causal relationships between beliefs and attitudes, attitudes and intentions, and intentions and behaviour. Continuing their investigation of the relationship between beliefs, attitudes, and behaviour, Ajzen (Ajzen, 1985) later developed the Theory of Planned Behaviour, which highlights the direct influence of external variables on beliefs, the influence of beliefs on attitudes and subjective norms, and the effect of these norms on intentions and behaviour.

In the context of science education, the relationships proposed by these theories are reflected in associations between teachers' attitudes and (i) their confidence and beliefs about self-efficacy (Tosun, 2000; Yates & Goodrum, 1990); (ii) the amount of time devoted to teaching science topics (Harlen & Holroyd, 1997; Koballa & Crawley, 1985); (iii) the extent to which standardized teaching methods and detailed guidelines from relevant institutions are applied (Appleton & Kindt, 1999; Harlen & Holroyd, 1997; Jarvis & Pell, 2004; Plonczak, 2008; S. Van Aalderen-Smeets & Walma Van Der Molen, 2013); and (iv) their ability to foster positive student attitudes toward science (Denessen et al., 2015; Harlen & Holroyd, 1997; Jarvis & Pell, 2004; J. Osborne et al., 2003; Van Driel et al., 2001; Weinburgh, 2007).

To better understand these dynamics, Van Aalderen-Smeets and Walma van der Molen (S. Van Aalderen-Smeets & Walma Van Der Molen, 2013) proposed a multidimensional framework for examining teachers' attitudes toward science teaching. This model identifies three interrelated components of attitude: cognitive beliefs (e.g., about science and one's competence to teach it), affective states (e.g., enjoyment or anxiety), and perceived control (e.g., self-efficacy and external constraints). Each of these dimensions contributes to a broader understanding of teacher attitudes and reflects their potential influence on classroom practice. Importantly, this framework avoids a reductionist view and instead integrates emotional, cognitive, and contextual elements to explain variations in teaching behaviour. The DAS instrument used in this study is grounded in this model, making it an appropriate tool for capturing the complex nature of teacher attitudes.

The distinction between traditional (transmission-oriented) and contemporary (constructivist) teaching approaches serves as a key interpretive lens in this study. Traditional approaches often stem from negative or underdeveloped attitudes and are characterized by teacher-centred methods focused on content delivery (Layton et al., 1993; Palmquist & Finley, 1997). These methods tend to discourage inquiry, limit student engagement, and promote surface-level learning (Donnelly, 2001; J. F. Osborne & Collins, 2000). Conversely, constructivist approaches encourage active learning, exploration, and conceptual understanding, aligning with more positive attitudes and contemporary views of science (Appleton, 2005; Brooks & Brooks, 1999; Koch, 2005).

Teachers' self-efficacy plays a central role in this context. Negative attitudes among teachers (Yates & Goodrum, 1990) and preservice primary school teachers (Department of Employment, Education and Training (DEET), 1989) may contribute to a lack of self-confidence in teaching science. This lack of confidence often arises in combination with insufficient teacher knowledge in the field of science (Astolfi, 1995; Erceg & Alajbeg, 2024; Goodrum et al., 2001; Harlen & Holroyd, 1997; Hodson, 1988; Jarvis & Pell, 2004; Johnston & Ahtee, 2006; J. Osborne & Simon, 1996; Summers & Kruger, 1992) and limited teaching experience (Appleton & Kindt, 1999). For example, low self-confidence—resulting from a teacher's own misunderstanding of science content—can ultimately have a detrimental impact on science instruction (Harlen & Holroyd, 1997). On the other hand, even confident and qualified teachers may encounter difficulties when teaching science, particularly when attempting to implement specific instructional strategies (Rowell & Gustafson, 1993). In

addition to the influence of attitudes on self-confidence, the reverse relationship—where self-confidence influences attitudes—also exists. Specifically, a teacher's confidence in teaching science reflects their belief in their own self-efficacy (Appleton & Kindt, 1999). Self-efficacy refers to an individual's perception of their ability to successfully carry out a specific task, as well as the belief that they possess the necessary skills to perform behaviours that lead to desired outcomes (Bandura, 1977b, 1977a, 1982). It is also considered one of the key factors influencing the development of teachers' attitudes toward science (Tosun, 2000). For example, low self-confidence and/or a weak sense of self-efficacy may lead to anxiety about teaching science, which in turn contributes to the development of negative attitudes toward science instruction.

The influence of attitudes on behaviour is confirmed by the findings of several studies (Crawley, 1990; Koballa & Crawley, 1985; Shireen Desouza & Czerniak, 2003; Simon, 2000). In line with these findings, positive attitudes toward science among teachers are a prerequisite for effective science instruction (Crawley, 1990; Koballa & Crawley, 1985; Shireen Desouza & Czerniak, 2003; Simon, 2000), alongside sufficient knowledge and understanding of scientific content (C. M. Czerniak & Schriver, 1994; Franz & Enochs, 1982; Hurd, 1982; Riggs, 1995; Simon, 2000), as well as the availability of adequate material resources and equipment (Helgeson et al., 1977). For example, a negative attitude toward teaching science may lead to the avoidance of science instruction altogether (Appleton & Kindt, 1999; Koballa & Crawley, 1985; Plonczak, 2008; Ramey-Gassert et al., 1996; Riggs, 1995), and a reliance on standardized, teacher-centred instructional methods, as well as on specific guidelines provided by official institutions and authorities (Appleton & Kindt, 1999; C. M. Czerniak & Schriver, 1994; Harlen & Holroyd, 1997; Ramey-Gassert et al., 1996; Riggs, 1995; S. Van Aalderen-Smeets & Walma Van Der Molen, 2013).

The standardized instructional approach reflects the principles of the so-called "deficit model" (Layton et al., 1993), in which teachers perceive their primary role as transmitting information to students. Within this model, students are viewed as "empty vessels" lacking their own ideas and explanations about the world around them, and their success is evaluated based on how well they can reproduce content from textbooks (Layton et al., 1993). This traditional practice of teaching science is associated with a traditional (narrow) view of science by the teacher (Palmquist & Finley, 1997). One such view, for example, is that science is a body of knowledge that is certain. Traditional teaching is particularly problematic given that it deprives students of opportunities for hands-on activities, inquiry, and discussion (Donnelly, 2001; J. F. Osborne & Collins, 2000; Wallace, 1996), in favour of the delivery of easily accessible information that is neither understood, analyzed, nor applied (Plonczak, 2008). For this reason, science education researchers recommend avoiding teaching strategies based on textbook content reproduction—such as teacher-led lectures, literature reviews, report writing, and the completion of standardized worksheets (Aikenhead, 2005; Appleton & Kindt, 1999; Australian Foundation for Science (AFS), 1991; C. M. Czerniak & Schriver, 1994; Jarvis & Pell, 2004; Plonczak, 2008). Instead, they advocate for modern strategies that are associated with a contemporary (broad) view of science, according to which scientists create scientific theories (Palmquist & Finley, 1997). Contemporary teaching strategies incorporate constructivist learning principles and hands-on activities (Curriculum Corporation, 1994; Tobin et al., 1994), with the aim of encouraging students to develop their own sustainable understanding of scientific concepts (Appleton, 2005; Brooks & Brooks, 1999; Koch, 2005; Tippins et al., 2002).

In addition to guidelines related to instructional strategies—that is, to pedagogical content knowledge (PCK)—science teachers also require support concerning subject matter knowledge (SMK), particularly in the form of additional explanations aimed at developing their own conceptual understanding (Harlen & Holroyd, 1997; Johnston & Ahtee, 2006;

Tobin & Fraser, 1988). This aligns with previously mentioned findings regarding teachers' misunderstandings of science content, which often include misconceptions similar to those found in students (e.g., Erceg & Alajbeg, 2024; Summers & Kruger, 1992). A lack of SMK can lead to low self-confidence and negatively affect science teaching practices (Harlen & Holroyd, 1997). This negative impact is reflected in the use of teaching strategies that avoid addressing students' challenging questions (Gallagher, 1994; Layton et al., 1993; She & Fisher, 2002), especially those related to their everyday experiences (Fourez, 2000a, 2000b; Johnston & Ahtee, 2006), since such questions often lack straightforward answers in textbooks. By choosing simpler and safer instructional strategies (Aikenhead, 2005; Appleton & Kindt, 1999; Jarvis & Pell, 2004), teachers tend to remain within their comfort zones (Plonczak, 2008).

A strictly standardized approach to science instruction may support the development of teachers' self-confidence in teaching science and, as such, foster positive attitudes toward science. Consequently, it can influence students' attitudes indirectly—through the positive attitudes of their teachers (C. Czerniak & Chiarelott, 1990). However, this approach does not directly promote the development of positive student attitudes toward science (Bricheno et al., 2001; Doherty & Dawe, 1985; Haladyna et al., 1982; Jarvis & Pell, 2004; Johnston & Ahtee, 2006; Yager & Penick, 1986). The primary reason lies in its lack of responsiveness to individual student needs, as well as its negative impact on the development of creativity, problem-solving skills, and the conceptual understanding of scientific content (Brooks, 2002; Harlen & Holroyd, 1997; Lee, 1995; J. Osborne & Simon, 1996; Plonczak, 2008). As a result, students often fail to see the relevance of learning science, which contributes to the declining number of those who choose to pursue science-related education and careers (Bricheno et al., 2001; Erceg et al., 2022, 2023; Fourez, 2000a, 2000b; Gardner, 1985; Kelly, 1987; S. Miller, 2001; J. Osborne et al., 2003; Smithers & Robinson, 1988).

Given this theoretical background, the present study focuses on three key constructs: teachers' attitudes toward science teaching, their epistemological views on science, and their self-reported classroom behaviours. These constructs were selected not only for their relevance to current reform efforts in Croatia, but also because they align with the theoretical premise that beliefs and attitudes influence teaching practices. The correlation between these constructs provides insight into the extent to which teacher orientations reflect either constructivist or transmission-based approaches. Thus, the theoretical rationale for investigating attitudes, views, and behaviours lies in the well-established understanding that teacher beliefs shape classroom practice. Attitudes and views about science influence how teachers interpret and present scientific knowledge, while behaviour reveals how these orientations manifest in the classroom. This integrated approach offers a comprehensive lens for examining the complexity of science teaching in the context of systemic educational change.

3. Materials and Methods

This cross-sectional study (Cohen et al., 2017) examined the attitudes of Croatian primary school teachers during the 2024/2025 school year, with the aim of addressing the following research questions:

1. What is the overall level and nature of professional attitudes toward science teaching among Croatian primary school teachers?
2. To what extent are more positive attitudes toward science teaching associated with broader and more contemporary views of science among teachers?
3. To what extent are more positive professional attitudes toward science teaching associated with the frequency of implementing science-related activities in the primary classroom?

To this end, an online questionnaire-based survey was administered. The study is part of the project "Exploring Perspectives on Primary School Physics Teaching in the Context of a Shortage of Qualified Teachers in Croatia".

3.1. Questionnaire

The primary data source for this study was the DAS instrument (S. Van Aalderen-Smeets & Walma Van Der Molen, 2013), a questionnaire designed to measure the attitudes of both preservice and in-service primary school teachers toward science teaching, as well as their self-reported science teaching behaviour. The DAS instrument is based on the theoretical framework developed by van Aalderen-Smeets et al. (S. I. Van Aalderen-Smeets et al., 2012), which defines attitudes as a construct comprising cognitive beliefs, affective states, and perceived control—making it particularly suitable for addressing our research questions on attitudes, views, and self-reported behaviour in science teaching. The original (Dutch) version of the instrument was validated in the Netherlands (S. Van Aalderen-Smeets & Walma Van Der Molen, 2013), followed by validated Turkish and Spanish versions (Korur et al., 2016) and, more recently, by English versions validated in the United States (Wendt & Rockinson-Szapkiw, 2018) and Australia (McDonald et al., 2021), supporting the reliability and cross-cultural applicability of the DAS instrument.

The questionnaire used in this study consisted of four sections. The first section gathers demographic data from participants, along with information related to their education and professional experience. In this study, teachers were asked about their year of birth, gender, the name of the completed study programme, the length of their teaching experience, their current place of employment, whether they are responsible for teaching the subject Science as part of the experimental programme, and the grade level they are currently teaching. These data provided contextual variables for interpreting patterns across teacher subgroups.

The second section measures the components—cognition, affect, and perceived control—of teachers' professional attitudes toward science, as defined in the theoretical framework (S. Van Aalderen-Smeets & Walma Van Der Molen, 2013). It consists of seven subscales comprising a total of 28 items, which reflect various opinions, beliefs, and/or feelings related to teaching science. Each subscale measures a specific subcomponent of teachers' professional attitude toward science, namely the perceived relevance of teaching science, gender-stereotypical beliefs, the perceived difficulty of teaching science, enjoyment in teaching science, anxiety in teaching science, self-efficacy, and contextual factors (S. I. Van Aalderen-Smeets et al., 2012; S. Van Aalderen-Smeets & Walma Van Der Molen, 2013) (see Results and Discussion). In this study, all seven subscales demonstrated acceptable internal consistency, with Cronbach's alpha coefficients greater than 0.5 (Gliem & Gliem, 2003). Six subscales showed high reliability ($\alpha \geq 0.797$), while the contextual factors subscale demonstrated lower reliability ($\alpha = 0.529$), consistent with its more heterogeneous nature (Gliem & Gliem, 2003).

The third section of the DAS instrument includes two subscales, each consisting of five items related to science activities and/or themes. These items are used to assess participants' views of science (see Results and Discussion). The first five items fall into the category of "narrow" (traditional) views, while the remaining five represent "broad" (contemporary) views of science. Both subscales demonstrated high internal consistency in the context of this study, with respective Cronbach's alpha coefficients of 0.823 and 0.936. This component was included to examine the relationship between teachers' attitudes and their underlying conceptions of science, which influence instructional decision-making (Lederman, 2007).

The fourth section of the instrument measures teachers' self-reported behaviour in teaching science. The corresponding scale includes seven items assessing the frequency of implementing specific science-related activities in the classroom (see Results and Discussion). Items 3–7 reflect student-centred, inquiry-based, and experiential learning—hallmarks of constructivist education. In contrast, items 1 and 2 are less pedagogically explicit, making them less clearly aligned with a specific learning orientation without additional contextual information. In this study, the scale demonstrated acceptable internal consistency, with a Cronbach's alpha coefficient of 0.779.

Each item in the DAS instrument was accompanied by a 5-point Likert scale. In the second section of the questionnaire, participants selected their responses on a scale from 1 (totally disagree) to 5 (totally agree); in the third section, choices ranged from 1 (none) to 5 (very much); and in the fourth section, participants selected their responses on a scale from 1 (seldom or never) to 5 (daily).

In the introductory section of the questionnaire, participants were informed about the purpose of the study and assured that the collected data would be used solely for research purposes, with full confidentiality and anonymity guaranteed. At the end of the questionnaire, following the recommendation of Cohen et al. (Cohen et al., 2017), we included an open-ended question: "Do you have any comments related to the questionnaire, in the form of personal opinions, beliefs, feelings, and/or similar?" This allowed participants the opportunity to go beyond the structured scope of the questionnaire.

Through the mediation of senior advisors on primary education from the Education and Teacher Training Agency, all primary school teachers in Croatia were invited via email to complete the questionnaire, which was translated into Croatian and administered in an online format for the purposes of this study. The translation process followed recommended approaches from the literature (Korur et al., 2016), ensuring structural, semantic, and conceptual equivalence. To maximize response rates, reminders were sent twice at one-month intervals. The questionnaire remained open for four months, from 28 October 2024 to 28 February 2025.

3.2. Sample

A total of 950 respondents, i.e., primary school teachers employed in elementary schools in Croatia during the 2024/2025 school year, participated in the survey. The estimated number of primary school teachers in the overall population is 9673, corresponding to the total number of lower-grade classes (Grades 1–4) in regular elementary schools in Croatia during the 2024/2025 school year (Ministarstvo znanosti obrazovanja i mladih RH [Ministry of Science, Education and Youth of Croatia], 2025). This estimate includes all types of classes (single-grade and combined) and educational programmes (including regular and experimental programmes conducted under the national initiative "Elementary School as a Whole-Day School"). For a population size of N = 9673, a sample size of $n = 950$ ensures a margin of error of $\pm 3.02\%$ at a 95% confidence level (Raosoft, 2025). According to (Cohen et al., 2017), for a population of 10,000, a sample size of 370 is sufficient to achieve a 95% confidence level with a $\pm 5\%$ margin of error. Therefore, the sample used in this study exceeds the required threshold, enhancing the statistical power and external validity of the results.

The sample consisted of 97% female and 3% male participants, reflecting the gender distribution typical of the teaching profession at the primary level in Croatia. Respondents represented four generational cohorts, with 13%, 57%, 27%, and 3% belonging, respectively, to the following generations: Baby Boomers (BB) (1946–1964), Generation X (1965–1980), Generation Y (1981–1996), and Generation Z (1997–2012). All participants completed an appropriate degree in primary education, in accordance with the Regulation on the

Appropriate Type of Education for Teachers and Professional Associates in Elementary School (Narodne novine [National Newspaper], 2019). The median length of teaching experience among the participants was 24 years, with a minimum of 0.02 years and a maximum of 44 years. The study included teachers from all counties of Croatia, with the highest number of respondents coming from the City of Zagreb (13.9%), followed by Osijek-Baranja County (13.8%) and Brod-Posavina County (10.8%) (see Figure 1). Of the total number of teachers, 8% were assigned to teach the subject Science as part of the Experimental Program "Elementary School as a Whole-Day School: A Balanced, Fair, Efficient, and Sustainable System of Education". This subgroup provides comparative insight into attitudes and behaviours in the context of ongoing reform.

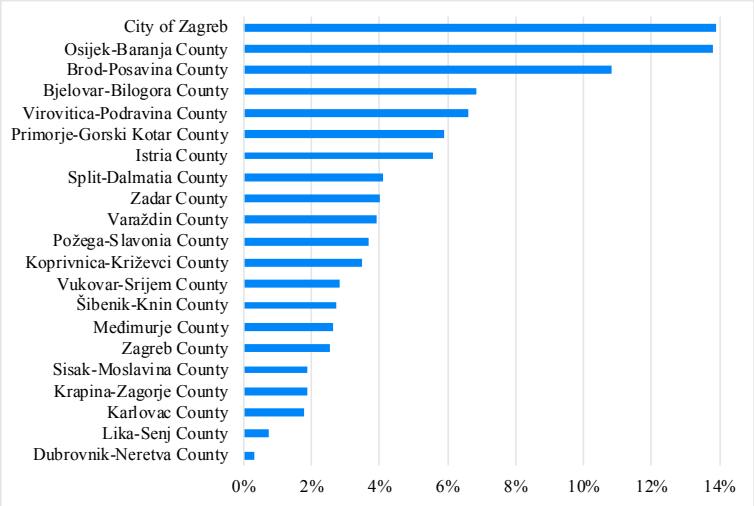


Figure 1. Distribution of respondents by counties of Republic of Croatia.

3.3. Procedures

To address the first research question, descriptive statistics were used to summarize the percentage distribution of responses for each questionnaire item based on a 5-point Likert scale (ranging from 1 to 5). This approach allows for a clear understanding of overall response patterns and central tendencies in professional attitudes (Cohen et al., 2017).

To further support the interpretation of teachers' responses, a synoptic summary of central tendency and variability was compiled for each questionnaire item. Given the non-normal distribution of the data, median values were calculated alongside the minimum, maximum, and interquartile range (IQR, defined as Q_1–Q_3), as recommended for ordinal Likert-scale data (Jamieson, 2004). These statistics offer a concise representation of typical response patterns and variability for each item related to the constructs of professional attitudes, views of science, and self-reported behaviour in science teaching.

In order to examine the second and third research questions, three composite variables were defined: attitude, view, and behaviour. These corresponded, respectively, to primary school teachers' professional attitudes toward teaching science, their epistemological views of science, and their self-reported behaviour in teaching science. Participants' responses were coded with numbers from 1 to 5, with higher values reflecting more positive professional attitudes, broader (contemporary) views of science, or the more frequent implementation of science-specific teaching activities. For each participant (n = 950), the mean score of the responses associated with each variable was calculated. These mean scores were then used as the final values representing the three defined variables.

To ensure the validity of the correlation analysis, the assumptions of normality, linearity, and homoscedasticity were assessed using SPSS v29.0.2.0 software. Normality was evaluated through the Shapiro–Wilk test for each variable. Linearity and homoscedasticity

were assessed by inspecting scatterplots of standardized predicted values against standardized residuals. Depending on whether the assumptions were met, either Pearson's correlation coefficient or Spearman's rank-order correlation was computed in SPSS. These statistical methods were selected due to their appropriateness for measuring the strength and direction of associations between continuous variables (Cohen et al., 2017).

4. Results and Discussion

The survey results are presented in tabular form and discussed according to the three key constructs investigated in the study: *Professional Attitude*, *View of Science*, and *Self-Reported Behaviour in Science Teaching*. To supplement the percentage distributions (Tables 1–3), summary statistics—including medians, ranges, and interquartile ranges (IQR)—were calculated for each item (Tables A1–A3 in Appendix A). In the sections on *View of Science* and *Self-Reported Behaviour in Science Teaching*, the results of Spearman's rank-order correlation and Pearson's correlation analyses are also presented and interpreted in relation to the theoretical framework.

4.1. Professional Attitude

The professional attitudes of Croatian primary school teachers toward teaching science are reflected in the percentage of selected responses on a 5-point Likert scale ranging from 1 (totally disagree) to 5 (totally agree) for each of the 28 items (Table 1). The statements, distributed across seven subscales, express various opinions, beliefs, and/or emotions and are used to measure the three core components of teachers' professional attitude toward science—cognitive beliefs, affective states, and perceived control—in line with the multidimensional model of attitudes (S. Van Aalderen-Smeets & Walma Van Der Molen, 2013). A positive attitude is indicated by selecting higher values on the subscales relevance of teaching science, enjoyment in teaching science, and self-efficacy, and by selecting lower values on the subscales gender-stereotypical beliefs regarding teaching science, difficulty of teaching science, anxiety in teaching science, and contextual factors. This approach aligns with the framework's emphasis on capturing attitudes as an interplay of beliefs, emotions, and perceived constraints, each of which can influence instructional behaviour.

Table 1. Percentages of teachers (n = 950) who selected a response on a scale from 1 (totally disagree) to 5 (totally agree) for each of the 28 statements expressing various opinions, beliefs, and/or feelings about teaching science. The highest percentage for each item is highlighted in bold.

	Totally Disagree (1)	(2)	(3)	(4)	Totally Agree (5)
COGNITIVE BELIEFS					
Relevance of teaching science					
1. I think that science education is essential for making primary school pupils more involved in technological problems in society.	1.6%	5.2%	**34.9%**	34.5%	23.8%
2. I think that science education is essential for primary school children's development.	0.5%	2.0%	20.1%	38.2%	**39.2%**
3. I think that science must be anchored in primary education as early as possible.	1.1%	2.4%	13.3%	22.9%	**60.3%**
4. I think that science education in the primary school is essential for pupils to be able to make good choices about their studies (e.g., profile choice and choice of a course).	1.3%	4.7%	30.4%	**35.6%**	28.0%

Table 1. *Cont.*

	Totally Disagree (1)	(2)	(3)	(4)	Totally Agree (5)
5. Science education is so important in the primary school that inexperienced teachers should receive additional training in this area.	4.1%	5.2%	22.7%	30.3%	**37.7%**
Gender-stereotypical beliefs regarding teaching science					
6. I think that boys in primary schools are more enthusiastic about experimenting with materials and chemical substances than girls are.	**42.4%**	18.2%	29.4%	8.2%	1.8%
7. I think that boys at primary school would be more likely than girls to choose assignments that are concerned with science.	**38.7%**	22.5%	29.4%	7.7%	1.7%
8. I think that I would unconsciously be more likely to choose a boy for a science demonstration than a girl.	**69.5%**	13.5%	13.7%	2.4%	0.9%
9. I think that male primary school teachers can do an investigation or technical assignment with pupils more easily than female teachers.	**82.0%**	8.4%	7.3%	1.8%	0.5%
10. I think that male primary school teachers experience more enjoyment in teaching science than female teachers.	**81.7%**	9.1%	7.8%	1.2%	0.2%
Difficulty of teaching science					
11. I think that most primary school teachers find it difficult to teach subjects concerning science.	**41.1%**	20.3%	28.2%	8.9%	1.5%
12. I think that most primary school teachers find science a difficult subject to teach in terms of content.	**40.0%**	19.9%	29.3%	8.9%	1.9%
13. I think that teachers find the topics that come up in science complicated.	**36.1%**	22.5%	29.6%	9.6%	2.2%
AFFECTIVE STATES					
Enjoyment in teaching science					
14. Teaching science makes me cheerful.	1.4%	1.6%	21.3%	35.2%	**40.5%**
15. I feel happy while teaching science.	1.6%	2.1%	23.7%	35.8%	**36.8%**
16. Teaching science makes me enthusiastic.	1.6%	2.8%	27.6%	**35.1%**	32.9%
17. I enjoy teaching science very much.	1.5%	2.4%	27.2%	**34.6%**	34.3%
Anxiety in teaching science					
18. I feel nervous while teaching science.	**60.3%**	21.6%	14.7%	2.3%	1.1%
19. I feel tense while teaching science in class.	**61.5%**	21.5%	14.5%	1.6%	0.9%
20. Teaching science makes me nervous.	**74.9%**	14.2%	9.7%	0.5%	0.7%
21. I feel stressed when I have to teach science in my class.	**73.1%**	15.2%	10.2%	0.9%	0.6%
PERCEIVED CONTROL					
Self-efficacy					
22. I have enough knowledge of the content of science to teach these subjects well in primary school.	0.9%	2.0%	13.5%	38.3%	**45.3%**
23. I am well able to deal with questions from pupils about science.	0.2%	0.7%	10.4%	41.9%	**46.8%**
24. I have a sufficient command of the material to be able to support children well in investigating and designing in class.	0.3%	1.8%	15.4%	**43.7%**	38.8%
25. If primary school children do not reach a solution during assignments about science, I think I can succeed in helping them make further progress.	0.2%	0.9%	9.1%	40.8%	**49.0%**

Table 1. *Cont.*

	Totally Disagree (1)	(2)	(3)	(4)	Totally Agree (5)
Contextual factors					
26. For me, the availability of a science teaching method is decisive for whether or not I will teach science in class.	0.5%	0.8%	18.0%	39.9%	**40.8%**
27. For me, the availability of a ready-to-use existing package of materials is essential to teaching science in class.	1.2%	1.9%	14.7%	34.3%	**47.9%**
28. For me, the support of my colleagues and the school is decisive for whether or not I will teach science in class.	5.9%	10.6%	**37.5%**	27.9%	18.1%

4.1.1. Cognitive Beliefs

Croatian primary school teachers generally agreed with all statements in the first subscale regarding the relevance of teaching science in primary school. This is indicated by the total percentage of responses (4) and (5) exceeding 50% and by the fact the highest percentages of responses are (4) or (5) for statements 2–5. Only for statement 1, "I think that science education is essential for making primary school pupils more involved in technological problems in society", was the most frequent response (3), although it differed by only 0.4% from response (4). It is worth noting that this item, although part of a validated international instrument, may appear somewhat inconsistent with the other items in the group due to its broader scope beyond the strictly professional and school-related context. This is acknowledged as a potential limitation in interpreting responses to this item. These findings lead to the conclusion that Croatian primary school teachers consider teaching science to be relevant, with 60.3% of respondents totally agreeing with statement 3, "I think that science must be anchored in primary education as early as possible." These findings are consistent with related studies in other countries (Asma et al., 2011; Cobern & Loving, 2002; Harlen & Holroyd, 1997; Korur et al., 2016; McDonald et al., 2021; S. Van Aalderen-Smeets & Walma Van Der Molen, 2013; Wendt & Rockinson-Szapkiw, 2018), in which both preservice and in-service primary teachers also expressed the view that teaching science is important and relevant at the primary school level.

Primary school teachers in Croatia did not express gender-stereotypical beliefs related to science teaching. On the contrary, the highest percentage of participants totally disagreed with all statements (6–10) within the subscale "Gender-stereotypical beliefs regarding teaching science". Moreover, over 80% of teachers totally disagreed with statements 9 and 10, which referred to teachers: "I think that male primary school teachers can do an investigation or technical assignment with pupils more easily than female teachers" and "I think that male primary school teachers experience more enjoyment in teaching science than female teachers". A few respondents expressed discomfort when reading the part of the questionnaire related to gender stereotypes, as reflected in comments such as "The group of statements implying that male teachers and boys are more competent and inclined toward science was upsetting" and "Female teachers are just as capable and interested in teaching as their male colleagues—these questions are discriminatory". Opposition to gender stereotyping in science teaching among in-service and preservice teachers has also been confirmed in previous studies (Korur et al., 2016; McDonald et al., 2021; Wendt & Rockinson-Szapkiw, 2018). Such beliefs align with the broader societal shift toward eliminating historical perceptions that men are more successful in science than women (Jones & Leagon, 2014). Although these findings may be interpreted as promising in

terms of ensuring equitable educational opportunities for students of all genders, various factors—such as environmental and historical influences—can interfere with teachers' ability to suppress automatically activated inappropriate stereotypes, including gender stereotypes (Peterson et al., 2016). Additionally, given the strong female majority in the sample (97%), it is possible that both the discomfort expressed and the overall responses to gender-stereotypical items were influenced by item phrasing and participant composition. Although the items were drawn from a validated instrument, future studies may consider rephrasing them in a less polemical tone or switching male and female subjects to reduce potential bias and improve neutrality.

Croatian respondents predominantly totally disagreed with the notion that science is difficult to teach in primary education. This disagreement was expressed across all statements (11–13) within the third subscale, *"Difficulty of teaching science"*. The highest percentage of totally disagreement (41.1%) was related to statement 11: *"I think that most primary school teachers find it difficult to teach subjects concerning science"*. These beliefs are consistent with those reported by teachers in one study (Korur et al., 2016). Preservice and in-service elementary educators in another study (Wendt & Rockinson-Szapkiw, 2018) perceived science as moderately difficult to teach, and preservice primary teachers in a futher study (McDonald et al., 2021) considered science to be difficult to teach. These differences in attitudes toward teaching science may stem from varying cultural and contextual factors (Jones & Leagon, 2014; Wendt & Rockinson-Szapkiw, 2018), including variations in teacher training, curriculum support, and exposure to science education coursework. The importance of localized studies such as this one is underscored by these findings, as attitudes toward teaching science may not be universally generalizable.

4.1.2. Affective States

Participants in this study expressed satisfaction with teaching science, with the majority (>50%) selecting responses (4) and (5) for each of the statements (14–17) within the *"Enjoyment in teaching science"* subscale. Additionally, some participants conveyed their enjoyment through comments such as *"Science topics have always been interesting to me, as they are to my students, so I look forward to teaching and learning together with them"*. Consistent with these results, the highest percentage of participants (over 60%) selected the lowest value (1) on the scale for each of the statements (18–21) related to anxiety. Notably, 74.9% of respondents totally disagreed with the statement *"Teaching science makes me nervous"*. Primary teachers in studies (Korur et al., 2016; McDonald et al., 2021; Wendt & Rockinson-Szapkiw, 2018) likewise reported that teaching science is enjoyable and that they do not experience high levels of anxiety related to teaching science (Korur et al., 2016; Wendt & Rockinson-Szapkiw, 2018). A certain level of anxiety may occasionally be present among preservice primary teachers prior to taking science education courses; however, this anxiety decreases after completing such coursework (McDonald et al., 2021). On the other hand, these findings are not consistent with those reported in the literature (Cady & Rearden, 2007; Jarvis & Pell, 2004; Jones & Leagon, 2014; Roth, 2014), which may once again be attributed to cultural and contextual differences in the settings where the studies were conducted, as well as to varying perceptions of occupational stress (Bursal, 2010; Klassen & Chiu, 2010; Korur et al., 2016). This further reinforces the value of examining teacher attitudes within local contexts, as affective dimensions—such as enjoyment and anxiety—can be shaped by both internal beliefs and external structural factors.

4.1.3. Perceived Control

A large majority of participants (>80%) rated their self-efficacy highly, selecting the upper values (4 and 5) on the Likert scale. Most respondents totally agreed with statements

22, 23, and 25, with the highest percentage of totally agreement (49.0%) relating to statement 25: *"If primary school children do not reach a solution during assignments about science, I think I can succeed in helping them make further progress"*. In addition to Croatian teachers, participants in related studies also demonstrated high levels of self-efficacy (Brígido et al., 2013; Bursal, 2010; Korur et al., 2016; J. Osborne et al., 2003; Tosun, 2000; Türkmen, 2013; Wendt & Rockinson-Szapkiw, 2018). This may be attributed to high self-confidence linked to teaching experience and low levels of anxiety (Korur et al., 2016). Supporting this interpretation are the results of our study, in which participants were predominantly experienced teachers (with a median of 24 years of professional experience) and reported very low levels of anxiety. In contrast, teachers (both preservice and in-service) in many other studies often exhibited low confidence in their own ability to understand and teach science (e.g., Bleicher, 2007; Bleicher & Lindgren, 2005; McDonald et al., 2021; Mulholland & Wallace, 1996). Feelings of unpreparedness among primary school teachers were especially pronounced in relation to teaching physical science (Banilower et al., 2013; Yates & Goodrum, 1990). A lack of confidence was also reflected in some of the participants' comments, such as *"I believe the university should prepare us better for teaching science topics"*, *"Universities should cover the same material that we are expected to teach students"*, and *"It would be beneficial to offer more professional development workshops on science education for primary school teachers, including practical examples for all grade levels"*.

Given the high self-efficacy reported by participants in this study, it might be expected that their teaching of science topics would not heavily depend on contextual factors. However, the majority of Croatian teachers indicated a reliance on such factors, selecting response (5) for statements 26 and 27. Notably, as many as 47.9% of teachers totally agreed with statement 27: *"For me, the availability of a ready-to-use existing package of materials is essential to teaching science in class"*. The majority of participants' comments further emphasized the dependency of science teaching on contextual factors. One such comment stated: *"Teachers have ideas and enthusiasm, but lack time and resources, and receive little support from school leadership and parents"*. In contrast, the highest proportion of teachers (37.5%) selected response (3) for statement 28, which pertains to support from colleagues and the school. This suggests that such support is not perceived as particularly relevant for teaching science, or that teachers hold both positive and negative views on the matter. The reliance on contextual factors in teaching science is consistent with findings from other studies (Appleton & Kindt, 1999; Banilower et al., 2013; Haney et al., 1996; Korur et al., 2016; McDonald et al., 2021; Wendt & Rockinson-Szapkiw, 2018). These factors (e.g., collegial collaboration, more time allocated to science in the curriculum, etc.) become even more important when considering that their absence may lead to increased teacher anxiety (Martin-Dunlop & Fraser, 2007; S. Van Aalderen-Smeets & Walma Van Der Molen, 2013) and a lower quality of science instruction at the primary school level (Roth, 2014; Wendt & Rockinson-Szapkiw, 2018).

4.2. View on Science

The views on science held by Croatian primary school teachers are reflected in their responses to items measuring both traditional and contemporary perspectives. These were assessed using a 5-point Likert scale ranging from 1 (none) to 5 (very much), applied to ten statements related to science topics and activities. A more contemporary or constructivist view of science is indicated by higher values on items 6–10 (broad views), while a traditional or transmission-oriented view is reflected in higher values on items 1–5 (narrow views). The results (Table 2) show that a large majority of participants (>80%) hold a broad view of science, as they selected high values (4 and 5) for items 6–10. However, at the same time, a large number of teachers (>70%) also selected high values (4 and 5) for

items 3–5, thus expressing a traditional view of science. This simultaneous attribution of importance to both traditional and contemporary views was further evident in the selection of response (3) on the Likert scale for the first two items, chosen by the largest proportion of participants (38.3% and 36.6%, respectively). These patterns suggest the internal coexistence of seemingly opposing views, reflecting the complexity of teachers' epistemological beliefs. While generational background (with 70% of participants from Baby Boomer and Generation X cohorts) may offer some contextual explanation, we acknowledge that attributing the observed mix of views to age is speculative and not empirically substantiated within this dataset. However, it is worth noting that during the period in which these teachers were educated and trained in Croatia, science education was often framed within more traditional and content-heavy curricula, with limited emphasis on contemporary scientific literacy or inquiry-based methods. It is possible that these generational experiences influenced current views of science and approaches to science teaching. As such, this interpretation is presented tentatively and not as a central explanatory factor. The coexistence of traditional and contemporary conceptions is consistent with findings from McDonald et al. (McDonald et al., 2021), where preservice primary teachers recognized the value of many activities reflecting a broader view of science, while also identifying the utility of some activities associated with traditional (narrow) views. Interestingly, their endorsement of narrow views diminished following participation in science education courses, suggesting that structured reflection and targeted instruction can shift teacher beliefs toward a more constructivist orientation. These results emphasize the importance of addressing epistemological beliefs explicitly in teacher education and professional development. Encouraging reflective thinking about the nature of science can help align teachers' conceptual frameworks with contemporary educational goals and support the implementation of inquiry-based practices in the classroom.

Table 2. Percentages of teachers (n = 950) who selected a response on a scale from 1 (none) to 5 (very much), indicating how strongly they believe each of the 10 activities and/or topics is related to science. Items 1–5 represent traditional (narrow) views of science, and items 6–10 represent contemporary (broad) views. The highest percentage for each item is highlighted in bold. Spearman's rank-order correlation coefficient (ρ) with professional attitudes toward science teaching is reported for the total score.

	None (1)	(2)	(3)	(4)	Very Much (5)
View on science					
1. Working with chemical substances	4.8%	12.0%	**38.3%**	24.9%	20.0%
2. Working in a laboratory	3.7%	8.5%	**36.6%**	26.4%	24.8%
3. Stars and planets	0.6%	2.6%	22.3%	36.6%	**37.9%**
4. Sustainable energy	0.2%	0.7%	12.0%	32.6%	**54.5%**
5. Carrying out tests	0.2%	1.3%	14.3%	29.9%	**54.3%**
6. Devising new ideas	0.1%	0.7%	11.5%	34.0%	**53.7%**
7. Improving existing things	0.1%	0.6%	15.7%	35.2%	**48.4%**
8. Communicating ideas to other people	0.2%	1.2%	15.1%	33.9%	**49.6%**
9. Acquiring knowledge	0.2%	0.9%	13.1%	31.5%	**54.3%**
10. Researching and inventing	0.1%	0.1%	10.5%	29.9%	**59.4%**

$\rho(950) = 0.081$, $p = 0.012$. Spearman's rank-order correlation between the composite score for views of science (items 1–10) and teachers' professional attitudes toward teaching science.

To examine the relationship between teachers' attitudes toward teaching science and their views on science, Spearman's rank-order correlation was conducted. The results revealed the existence of a statistically significant but very weak positive correlation, $\rho(950) = 0.081$, $p = 0.012$ (significant at the 0.05 level; see Table 2). This suggests that teach-

ers with more positive attitudes toward teaching science tend to express slightly more favourable views across both traditional and contemporary dimensions of science, though the strength of this association is very small and does not the existence of indicate a clear directional trend. The weakness of this correlation may reflect the complexity and multi-dimensional nature of the construct "view on science," which is not necessarily directly influenced by professional attitudes. That is, even though teachers may hold positive attitudes toward teaching science, their fundamental understanding of science often remains rooted in traditional epistemological frameworks, shaped by their own educational experiences or sociocultural contexts (Lederman, 2007). For example, a teacher may be motivated and confident in teaching science, yet still perceive it primarily as a collection of facts rather than as a dynamic process of inquiry. This disconnect highlights the potential gap between affective and cognitive dimensions of teacher attitudes and the epistemological underpinnings of their instructional approaches. Such deeply held epistemological beliefs tend to be resistant to change and require targeted, reflective intervention. As suggested by Akerson and Hanuscin (Akerson & Hanuscin, 2007), shifting toward more contemporary, constructivist conceptions of science necessitates professional development that goes beyond technique, incorporating explicit engagement with the nature of science itself. These findings therefore underscore the importance of incorporating explicit discussions about the epistemology of science into both initial teacher education and continuing professional development programmes in order to better align teachers' attitudes, views, and instructional practices in support of high-quality science education.

4.3. Self-Reported Behaviour in Science Teaching

The frequency of implementing instructional activities specific to science was reported by teachers through their responses to each of the 7 items (Table 3). The majority of participants selected low values (1 or 2) on the Likert scale for as many as 6 of the items (2–7), indicating a low frequency of implementing science-specific teaching activities. In response to the first item, the most frequently selected value was (3), chosen by 28.2% of respondents, although responses (2), (4), and (5) were also similarly represented. This suggests the existence of a relatively neutral or varied pattern in general science instruction, with a more pronounced lack of engagement in specific activities, such as organizing field excursions within science education or analyzing technological aspects of products.

The relationship between teachers' attitudes toward teaching science and the frequency of conducting science-related activities in the classroom was examined using Pearson's correlation. The results revealed a moderate positive, and statistically significant correlation between attitudes and activity implementation, $r(950) = 0.396$, $p < 0.001$ (significant at the 0.01 level; see Table 3). This moderate correlation suggests the existence of a meaningful association: teachers with more positive attitudes are more likely to engage in science-specific instructional practices. While not strong, this level of association is noteworthy in the context of educational research, where moderate correlations are often considered both theoretically and practically meaningful. These findings support the idea that positive attitudes toward teaching science can act as a motivational driver, encouraging teachers to adopt more active and inquiry-based approaches in their classrooms. At the same time, the moderate effect size also indicates the likely influence of additional factors—such as institutional support, curriculum flexibility, availability of resources, and perceived self-efficacy. These external and internal conditions may either enable or constrain the translation of attitudes into consistent classroom behaviour.

Table 3. Percentages of teachers (n = 950) who selected a response on a scale from 1 (seldom or never) to 5 (daily), indicating how frequently they implement each of the seven science-related teaching activities in the classroom. The highest percentage for each item is highlighted in bold. A Pearson correlation coefficient (r) with professional attitudes toward science teaching is reported for the overall behaviour scale.

	Seldom or Never (1)	(2)	(3)	(4)	Daily (5)
Self-Reported Behaviour in Science Teaching					
1. How often do you teach science in your class (separately and/or integrated)?	3.6%	24.3%	**28.2%**	22.7%	21.2%
2. How often do you specifically identify activities in class as technical/technology/technology lessons/investigation/science etc.?	3.4%	**43.3%**	41.9%	10.7%	0.7%
3. How often do you personally devise and prepare a science lesson?	9.4%	**37.9%**	28.1%	18.5%	6.1%
4. How often do you make an excursion with your pupils in the context of science education (museum, exhibition, company visit, etc.)?	15.1%	**78.3%**	6.2%	0.4%	0.0%
5. How often do your pupils test or analyse an existing or personally designed product on its technical aspects?	**46.2%**	43.2%	8.9%	1.3%	0.4%
6. How often do you carry out an investigation together with your pupils?	2.8%	**48.4%**	35.9%	8.5%	4.3%
7. How often are your pupils allowed to genuinely carry out an investigation or try to discover something without following a pre-set procedure?	30.8%	**44.6%**	16.2%	3.9%	4.4%

$r(950) = 0.396$, $p < 0.001$. Pearson's correlation between the composite score for self-reported science teaching behaviour (items 1–7) and teachers' professional attitudes toward teaching science.

The observed relationship underscores the importance of developing teachers' attitudes early through targeted interventions in both initial teacher education and ongoing professional development. Similar findings have been reported in other studies (Haney et al., 1996; McDonald et al., 2021; S. I. Van Aalderen-Smeets et al., 2012; Yilmaz-Tuzun, 2008). For example, McDonald et al. (McDonald et al., 2021) found that preservice teachers' intentions to implement science activities improved during participation in science education courses—highlighting the transformative potential of reflective, well-designed teacher preparation programmes.

5. Conclusions

This cross-sectional study was motivated, on the one hand, by the ongoing decline in interest in studying and pursuing professional development in the field of science, and on the other hand, by the current implementation of the experimental science curriculum in the lower grades of elementary school in Croatia. The research was conducted during the 2024/2025 school year among Croatian primary school teachers, using the validated DAS questionnaire, which is grounded in an appropriate theoretical framework of attitudes.

The results of the study provide insight into the professional attitudes, views, and self-reported behaviour of primary school teachers in the context of science education, as framed by the research questions.

With regard to the first research question, Croatian primary school teachers exhibit highly positive professional attitudes toward teaching science. They value its importance, enjoy teaching it, and do not express notable anxiety, self-doubt, or gender-stereotyped beliefs. However, their attitudes also reflect a certain dependence on external, contextual factors, such as support and resources.

In relation to the second research question, the findings show that teachers generally hold contemporary and broadly defined views of science. Nevertheless, traditional elements are still present in their thinking, indicating that further development of their epistemological understanding of science remains necessary.

Addressing the third research question, the analysis of self-reported behaviour reveals that teachers do engage in science-related activities, though not as frequently as might be expected. This suggests the need for greater institutional support and opportunities for collaboration to foster the more consistent implementation of science-specific teaching practices.

Finally, the correlation analysis showed that more positive attitudes are associated with more contemporary views of science and greater implementation of science-related activities. While the correlation between attitudes and views was weak, and the one between attitudes and behaviour was moderate, these results highlight the complex and interconnected nature of teachers' professional attitudes, beliefs, and classroom practices. They also underscore the importance of fostering positive attitudes as a foundation for improving science education at the primary level.

To further clarify the theoretical grounding of the study, we have elaborated on how the constructs of attitudes, views, and behaviour are conceptually linked to broader educational theories, particularly the contrast between constructivist and transmission-oriented teaching approaches. This theoretical lens not only informed the interpretation of our findings but also guided the development of our research questions. The choice of the DAS instrument was guided by its alignment with the multidimensional model of attitudes proposed by Van Aalderen-Smeets and Walma van der Molen (Walma Van Der Molen & Van Aalderen-Smeets, 2013), which explicitly captures cognitive, affective, and control-related dimensions relevant to teaching science.

Additionally, theoretical explanations discussed earlier—such as the role of constructivist teaching in promoting inquiry-based practices—are now integrated into the discussion section, where they are used to interpret patterns observed in teachers' self-reported behaviours. This strengthens the theoretical coherence of the study and demonstrates that the research was conceptually grounded, rather than driven solely by the context of reform.

The obtained results represent a valuable contribution to understanding teachers' attitudes and behaviour in the context of the ongoing elementary education reform in science in Croatia. This is particularly important given that the attitudes of Croatian primary school teachers have not yet been investigated within the framework of the TALIS, as Croatia does not participate in the additional survey module designed for primary school teachers. These findings can be used, for example, to inform the reform process by supporting the planning of realistic outcomes that consider teachers' attitudes—particularly those reflecting a dependence on contextual factors in science instruction. The results also provide a foundation for the development of initial teacher education and continuing professional development programmes for primary school teachers, as well as for future research aimed at improving the quality of science education at all levels. The scientific contribution of this study, based on a representative sample of Croatian teachers, is further reflected in its confirmation of the applicability of the DAS questionnaire for measuring attitudes across diverse cultural contexts, as suggested by Wendt and Rockinson-Szapkiw (Wendt & Rockinson-Szapkiw, 2018).

Despite these contributions, this study has certain limitations. The generalizability of the results is limited to primary school teachers in Croatia. Furthermore, the results reflect the specific temporal context in which the research was conducted (the 2024/25 school year), which coincides with the implementation of the current educational reform. In such a transitional period, shifts in teachers' attitudes and behaviours are possible. This is

illustrated by the fact that 8% of our respondents, who were directly involved in piloting the experimental programme, expressed more positive attitudes on 24 items, while non-reform teachers did so on 18 items, with 3 items showing no difference. Although this suggests the existence of a trend toward more positive attitudes among reform participants, the pattern is not fully consistent and warrants further analysis in the next phase of the research. Since the DAS instrument used for data collection was based on self-assessment, respondents may have provided socially desirable responses, presenting their attitudes and behaviours in a more positive light than may be the case in practice. Although the instrument is based on a theoretically validated framework, the lack of empirical validation—such as exploratory factor analyses—limits insight into its internal structure. Furthermore, while the questionnaire included an open-ended question, further research is needed to gain a deeper understanding of teachers' attitudes, views, and behaviours, as well as the causal relationships between these dimensions.

Building on the above, we plan to conduct future research using a combination of quantitative and qualitative methods (e.g., interviews, direct classroom observations, etc.) in order to gain a deeper understanding of the quantitative findings. Changes in teachers' attitudes, views, and behaviours over time will be tracked through longitudinal study, while intervention studies will explore the effects of targeted activities on teachers' attitudes, knowledge, and practice—particularly in the context of physical science, which is often perceived as more demanding than other branches of science. Comparative analyses of professional attitudes among different groups of teachers (e.g., based on geographic location, age, gender, type of education, work experience, etc.) could further expand relevant insights, helping to identify specific teacher needs. Future studies could focus on analyzing the impact of the educational reform on teachers' attitudes and practices in Croatia. Expanding the research to the international level, particularly within the EU, could contribute to a better understanding of similarities and differences in approaches to science education, supporting the transfer of good practices and the development of shared education policies grounded in scientific evidence.

Author Contributions: Conceptualization, N.E.; methodology, N.E.; validation, N.E.; formal analysis, N.E. and T.I.; investigation, T.I. and N.E.; resources, N.E.; data curation, N.E. and T.I.; writing—original draft preparation, N.E.; writing—review and editing, N.E. and T.I.; visualization, N.E.; supervision, N.E.; funding acquisition, N.E. All authors have read and agreed to the published version of the manuscript.

Funding: This work has been supported in part by the University of Rijeka under the project number uniri-iskusni-prirod-23-33.

Institutional Review Board Statement: The study was approved by the Ethics Committee of the Faculty of Physics, University of Rijeka, Croatia (KLASA:602-03/24-01/167, URBROJ:2170-137-003-01-24-2, 28 October 2024).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to ethical restrictions.

Acknowledgments: The authors would like to thank all the participants who took part in this study. We also express our gratitude to the senior advisors at the Education and Teacher Training Agency for their mediation with primary school teachers. During the preparation of this manuscript, the authors used InstaText and ChatGPT (4.0) to enhance the language and readability. Following their use, the authors thoroughly reviewed and edited the content as necessary and accept full responsibility for the final version of the publication.

Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

DAS	Dimensions of Attitude toward Science
TALIS	Teaching and Learning International Survey
ISCED	International standard classification of education
PCK	pedagogical content knowledge
SMK	subject matter knowledge
SPSS	Statistical Package for the Social Sciences

Appendix A

Table A1. Summary of central tendency and variability in teachers' responses to items on professional attitudes, based on median, minimum, maximum, and interquartile range (IQR, defined as Q_1–Q_3).

Item No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Median	4	4	5	4	4	2	2	1	1	1	2	2	2	4
Min	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Max	5	5	5	5	5	5	5	5	5	5	5	5	5	5
IQR (Q_1–Q_3)	3–4	4–5	4–5	3–5	3–5	1–3	1–3	1–2	1–1	1–1	1–3	1–3	1–3	4–5
Item No.	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Median	4	4	4	1	1	1	1	4	4	4	4	4	4	3
Min	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Max	5	5	5	5	5	5	5	5	5	5	5	5	5	5
IQR (Q_1–Q_3)	3–5	3–5	3–5	1–2	1–2	1–2	1–2	4–5	4–5	4–5	4–5	4–5	4–5	3–4

Table A2. Summary of central tendency and variability in teachers' responses to items on views of science, based on median, minimum, maximum, and interquartile range (IQR, defined as Q_1–Q_3).

Item No.	1	2	3	4	5	6	7	8	9	10
Median	3	4	4	5	5	5	4	4	5	5
Min	1	1	1	1	1	1	1	1	1	1
Max	5	5	5	5	5	5	5	5	5	5
IQR (Q_1–Q_3)	3–4	3–4	3–5	4–5	4–5	4–5	4–5	4–5	4–5	4–5

Table A3. Summary of central tendency and variability in teachers' responses to items on self-reported behaviour in science teaching, based on median, minimum, maximum, and interquartile range (IQR, defined as Q_1–Q_3).

Item No.	1	2	3	4	5	6	7
Median	3	3	3	2	2	2	2
Min	1	1	1	1	1	1	1
Max	5	5	5	4	5	5	5
IQR (Q_1–Q_3)	2–4	2–3	2–3	2–2	1–2	2–3	1–2

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