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Teachers' Personal and Teaching Epistemic Practices: A Four-Country Survey and Interview Exploration of Argumentation Implementation

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ABSTRACT

Three hundred and eighteen in-service teachers from Greece, Cyprus, Romania and Hungary participated in a professional training program aimed at promoting their metacognitive and epistemic thinking and practices, with argumentation as a prominent teaching practice. Pre-program survey results revealed that teachers' personal and teaching epistemic practices were underdeveloped, with particularly low engagement in the latter. Personal epistemic practices predicted teaching ones. Cultural differences emerged, with Greek and Cypriot teachers reporting higher engagement in both epistemic practices than Romanian and Hungarian teachers. In-depth interviews with six Greek and Cypriot teachers who implemented argumentation post-program indicated that argument-based practices improved students' epistemic understanding, particularly in appreciating multiple perspectives, evaluating sources and using evidence. Teachers acknowledged receiving limited preparation for promoting students' epistemic understanding and argumentation skills. These findings highlight the need for higher education programs to develop pre- and in-service teachers' epistemic practices. Implications for higher education and policymakers are discussed.

1 | Introduction

In today's AI-driven and digitally complex world, developing students' epistemic cognition is pivotal for enabling them to reason about complex socio-scientific issues (Barzilai and Chinn 2018; Christodoulou and Iordanou 2021; Hendriks et al. 2020; Kuhn 2022). Epistemic cognition—including both epistemic beliefs about knowledge and the process of knowing and epistemic practices, that is, practices related to knowing (Barzilai and Chinn 2024; Iordanou 2016b)—supports higher-order thinking (Kuhn 2022) and academic achievement (Greene et al. 2018).

Teachers play a fundamental role in shaping students' epistemic cognition through their approach to knowledge and their teaching practices, as reflected in their selection of instructional activities (e.g., argumentation), feedback, assessment practices and dialogic interactions with students (Brownlee et al. 2012; Muis and Duffy 2013; Zsigmond et al. 2025). Teachers with more advanced epistemic beliefs tend to adopt effective teaching epistemic practices, benefiting student learning outcomes (Barnes et al. 2020; Buehl and Fives 2016; Sebastián et al. 2025). Yet, the epistemic cognition literature has mostly focused on learners, leaving teachers largely overlooked (Chinn et al. 2011; Greene and Yu 2016; Iordanou 2016b). Research on teachers' epistemic cognition is still an emerging field (Lunn Brownlee et al. 2017) and existing studies generally examine teachers as learners rather than in their instructional role (Baytelman et al. 2020; Ferguson and Brownlee 2018). Thus, our understanding of teachers in their teaching role remains limited (Barnes et al. 2020). Furthermore, although epistemic cognition is argued to

be context-specific (Chinn and Sandoval 2018; Kuhn and Park 2005), empirical evidence on how contextual factors influence teachers' epistemic beliefs and practices remains scarce.

Addressing these gaps, the present study examined teachers' teaching epistemic practices, defined as practices that foster students' epistemic growth and whether teachers' personal epistemic practices (employed for their own learning) predict their teaching ones. The contextual nature of these epistemic practices was also examined by surveying teachers from four European countries—Greece, Cyprus, Hungary and Romania—and pursuing complementary interviews to capture other contextual factors (e.g., educational policy, school administration, curriculum, teacher education and professional development) that teachers identify as shaping the implementation of their teaching epistemic practices. These interviews took place after teachers participated in a professional development program designed to support teaching epistemic practices that foster students' metacognitive and epistemic thinking and skills, focusing on argumentation and the use of argument-based classroom activities.

2 | Background

2.1 | Epistemic Cognition and Culture

Sociocultural research (Harkness and Super 2021; Rogoff 2016) has shown that cognitive activities are socially embedded, being acquired within communities and transmitted across generations. Adopting this sociocultural perspective, many researchers conceptualise epistemic cognition as shaped by the social and cultural contexts in which individuals develop (Kiili et al. 2018). Cultures emphasising social harmony may discourage epistemic practices such as argumentative discussion, viewing them as disruptive to group cohesion, whereas cultures valuing individualism are generally more supportive of such practices (Kuhn and Park 2005). Cultural differences in epistemic beliefs and practices have been widely observed between Eastern and Western contexts (see De Oliveira and Nisbett 2017; Nisbett 2010). For example, Kuhn and Park (2005) found that Americans endorsed discussion more strongly than Korean and Japanese participants. Lammassaari et al. (2024)—focusing specifically on teachers' epistemic beliefs, which is the focus of the present study—identified differences between Finnish and Taiwanese teachers, with Taiwanese teachers valuing both reflective-collaborative and knowledge transmission approaches, consistent with the 'Chinese paradox' where memorising and understanding are viewed as complementary (Lin et al. 2015). Differences within Europe have also been reported, with Swedish students less likely to believe in single correct answers than German students, and teacher support being associated with different epistemic outcomes in the two countries (Bernholt et al. 2021).

Overall, although there is some evidence suggesting cultural differences in teaching epistemic practices, our understanding of the relation between culture and teaching epistemic practices remains incomplete. More research examining teachers' epistemic practices across cultural contexts is needed to support the design of effective, culturally informed interventions, a need that the present study aims to address.

2.2 | Teaching Epistemic Practices: The Role of Higher Education

In addition to culturally embedded beliefs and stances, the education teachers receive or do not receive also influences their epistemic practices. For example, in the context of argumentation, preservice teachers often struggle to generate diverse arguments on socio-scientific issues, especially when they hold rigid, simplistic epistemic beliefs and/or have limited prior knowledge of the topics (Baytelman et al. 2020). This is concerning given evidence that teachers' own argumentation skills are closely linked to their teaching epistemic practices (Lytzerinou and Iordanou 2020). Moreover, although many elementary teachers recognise the importance of argumentation, they rarely implement it in practice, continuing to rely heavily on teacher-centred pedagogies (Kutluca 2021). Preservice teacher education in the context of higher education does not seem to support teachers in developing efficient teaching epistemic practices. Studies on pre-service teachers (e.g., García and Sebastián 2011; Rodriguez and Cano 2007; Walker et al. 2012) show that most final-year pre-service teachers do not exhibit significant growth in epistemic cognition compared to their first-year counterparts, implying that higher education does not sufficiently support the development of epistemic cognition. The inadequacies in the epistemic competencies of both pre-service and in-service teachers highlight the need for their participation in specialised interventions that promote the growth of epistemic cognition, with the ultimate goal of enhancing the effectiveness of their teaching epistemic practices (Bråten et al. 2017; Sebastián et al. 2025).

2.3 | Approaches to Developing Epistemic Practices

The development of epistemic practices requires self-awareness of one's cognitive processes—including recognition of personal strengths and weaknesses in different contexts—as well as awareness of the nature and source of knowledge itself (Kuhn 2000) and the criteria used to justify it (Schommer-Aikins 2004; Iordanou 2016b). Research has identified several promising approaches for developing epistemic practices, such as engagement in reflective activities, argumentation and model-based inquiry. Each of these approaches is briefly discussed below.

Engagement in reflective practices is central to many approaches aimed at enhancing epistemic practices, emphasising the importance of critically examining beliefs and thought processes about knowledge and learning (Barzilai and Chinn 2018; Bråten et al. 2017; Iordanou 2022a). Explicit reflection on beliefs about knowledge is critical for epistemic change and aligning teachers' thinking with constructivist teaching practices (Schraw et al. 2017 cited in Bråten et al. 2017). This reflection fosters deeper engagement with instructional practices that support active, student-centered learning (Buehl and Beck 2015; Lunn Brownlee et al. 2017).

Frameworks such as the 3R-EC framework of epistemic reflexivity (Lunn Brownlee et al. 2017, 2019) and the Apt-AIR framework of epistemic performance (Barzilai and Chinn 2024) highlight the role of structured reflection in recalibrating teachers' epistemic practices. These frameworks suggest that individual and collective reflection on epistemic aims, reliable processes and teaching practices can foster advanced epistemic practices (Lunn Brownlee et al. 2017, 2019; Mor-Hagani and Barzilai 2022). By aligning their beliefs and objectives with the processes they wish to cultivate in students, teachers can promote deep understanding, reasoned argumentation and reflective thinking in their classrooms (Lunn Brownlee et al. 2019; Mor-Hagani and Barzilai 2022).

Beyond engagement in reflective activities, engaging in argumentative discourse has shown promise as an effective approach for developing teachers' epistemic practices. As demonstrated by Iordanou and Constantinou (2014), sustained engagement in argumentative activities supported teachers in developing more advanced epistemic standards and epistemic practices, such as using evidence-based reasoning. Pre-service teachers shifted from presenting claims as self-evident truths to actively employing data to support their positions and considering alternative interpretations of evidence. The process of coordinating evidence with claims, and teachers' awareness of the need to do so, came under increasing conscious control through argumentative practice. Additionally, teachers demonstrated growth in their meta-level understanding about the role of evidence, as reflected in their increasing meta-level statements about evidence use in discussions. This suggests that argumentation can serve as a productive pathway for making tacit epistemic beliefs explicit and supporting the development of more evaluativist epistemic beliefs and practices among teachers (Iordanou 2016a; Rapanta and Felton 2022).

A third evidence-based approach for promoting teachers' epistemic practices is model-based inquiry. Model-based programs explicitly promote epistemic cognition by encouraging teachers to develop, test and revise models as representations of ideas about the natural world (Windschitl et al. 2008). Engagement in model-based inquiry led to shifts in teachers' epistemic cognition, moving them from a focus on 'proving' hypotheses to testing and revising models based on evidence (Windschitl et al. 2008). Moreover, teachers were able to reflect on their changes in epistemic thinking through discussions with peers, which reinforced the importance of dialogic teaching partnerships in facilitating sustained change (Gholami, in press, cited in Bråten et al. 2017). These discussions helped teachers refine their understanding and practices, underscoring the link between epistemic cognition and instructional approaches.

While these approaches have shown promise in improving teachers' epistemic cognition and teaching epistemic practices, programs aimed at promoting teachers' epistemic cognition remain scarce; there is a pressing need for more comprehensive programs to support teachers' professional development in terms of advancing their epistemic beliefs and practices. In response to this need, the training program introduced in our study has been designed as a targeted approach to enhancing teachers' metacognitive and epistemic teaching practices. Specifically, the training adopts a holistic approach to fostering metacognition by addressing concepts and skills closely related to social and epistemic cognition, along with strategic thinking. The overarching aim is to promote teachers' knowledge of, and reflection on, the potentials and constraints of the human mind.

2.4 | The Present Study

In this study, we examined teachers' self-reported epistemic practices for their own learning (personal epistemic practices) and for supporting students' learning (teaching epistemic practices), prior to their participation in an intervention program. This allowed us to assess their initial level of development, given previous research showing that teachers' epistemic beliefs and practices are closely connected to their teaching and the support they provide for students' epistemic growth (Aguilar-Valdés et al. 2024). We focused particularly on teachers' ability to judge the credibility of claims—a fundamental epistemic practice for 'competent outsiders,' that is, individuals who approach science as everyday users rather than as scientists (Feinstein 2011)—which is based on understanding science as a social practice (Kuhn et al. 2008; Osborne et al. 2022; Oreskes 2019). Using an instrument developed for this study, we explored these abilities and further examined teachers' experiences and reflections on implementing argumentation in their classrooms after completing the professional training program, which aimed to enhance their epistemic teaching practices and promote students' metacognitive and epistemic thinking and skills, focusing particularly on argumentation. The program consisted of twelve 90-min online training sessions, conducted over a three-month period. Through interviews, we examined teachers' views on the gains they observed in their students, the challenges they encountered, and their suggestions for curriculum developers and policymakers. The study included teachers from four European countries—Greece, Hungary, Cyprus and Romania—to investigate how cultural and educational contexts may influence teachers' epistemic practices. Understanding possible cultural differences is particularly valuable for designing culturally responsive professional development programs.

In particular, the present study addressed the following research questions:

1. What are teachers' self-reported personal and teaching epistemic practices, particularly in relation to argumentation and evaluation of source credibility?
2. To what extent do teachers' personal epistemic practices predict their teaching epistemic practices across different domains?
3. How do teachers' personal and teaching epistemic practices vary across four European countries?
4. How do teachers perceive the impact of the professional development program on: (a) their implementation of argumentative practices, including any barriers they foresee and their recommendations for overcoming them, (b) their students' social and communication gains and (c) their own professional growth?

TABLE 1 | Profiles of teachers who participated in the interviews.

	Age (yr)	Gender	Years of teaching experience	Level of education	Teaching subjects	Country
Teacher 1	38	Female	16	Primary	Greek language	Greece
Teacher 2	56	Female	31	Secondary	English	Cyprus
Teacher 3	49	Female	27	Primary	Greek, History, Religious Studies	Cyprus
Teacher 4	52	Female	31	Secondary	Physics	Greece
Teacher 5	39	Female	17	Secondary	Greek language	Greece
Teacher 6	44	Male	12	Primary	Greek, Geography	Greece

TABLE 2 | Subject domain specialisation of teachers who participated in the survey.

	Secondary education							
Country	STEM	Languages	Social studies	Physical education	Special education	Art	Non-specified	Primary education
Greece	10	24	0	0	0	0	0	34
Cyprus	15	28	3	1	1	2	1	30
Romania	11	21	16	0	0	0	0	62
Hungary	21	38	0	0	0	0	0	0
Total	57	111	19	1	1	2	1	126

3 | Method

3.1 | Participants

The study included 318 teachers from four European countries, with numbers in parentheses representing men and women, respectively: 68 from Greece (16, 52), 81 from Cyprus (13, 68), 110 from Romania (5, 105) and 59 from Hungary (3, 56). The whole sample participated in the survey assessing their epistemic practices. Six teachers from Greece ($n = 3$) and Cyprus ($n = 3$) took part in in-depth interviews about their experiences with implementing argumentation in their classrooms. Participants were recruited from among teachers who had participated in the professional development program and had implemented argumentation in their classrooms. Table 1 presents the profiles of the six teachers who participated in the interviews and Tables 2 and 3 present the profiles of the 318 teachers who participated in the survey, including subject domain specialisation, age and years of experience.

TABLE 3 | Age and years of experience of teachers who participated in the survey.

	Age		Years of experience	
	Mean (SD)	Range	Mean (SD)	Range
Greece	48.44 (8.11)	28–60	19.40 (8.03)	3.0–38
Cyprus	45.65 (6.78)	29–62	17.78 (9.58)	2.5–38
Romania	46.90 (5.93)	26–59	24.29 (7.18)	4.0–39
Hungary	50.71 (8.31)	36–66	24.94 (10.25)	2.0–44
Total	47.40 (7.22)	26–66	21.32 (9.01)	2.0–44

3.2 | Implementation

Teacher 1 applied the argumentation practice to fourth-grade students in Greek lessons. She had received prior training in dialogue-based and argumentation-based teaching methods through a workshop in Austria. Teacher 2 implemented the argumentation practice with third-year Lyceum students. She had prior experience using dialogue and argumentation in her lessons, including debates and delivering the syllabus of the English subject which incorporates elements of argumentation. Teacher 3 implemented the argumentation practice with fifth- and sixth-grade students in Greek, History and Religious Studies lessons and had prior experience with argumentation through participation in a relevant program at the University of Cyprus. Teacher 4 applied the argumentation practice to second-year Lyceum students. She had no specific training on dialogue and argumentation for classroom settings, but her postgraduate studies focused on teaching evaluation. She is a member of the Scientific Union of Physics teachers and contributes to educational policy by advocating for the inclusion of such practices in the classroom. Also, she implements these practices to promote scientific thinking among students. Teacher 5 implemented the argumentation practice with second- and third-year Gymnasium students. She implements

such strategies when the curriculum includes relevant activities, albeit informally and without a well-defined structure. Teacher 6 applied the argumentation practice to fifth-grade students in Greek and Geography lessons. He implements such strategies when the curriculum includes relevant activities.

3.3 | Measures

This study was part of a larger project, the Pro-Me-ToM project. In the present work, we focus on teachers' self-reported epistemic practices prior to their engagement in the professional development program.

3.3.1 | Epistemic Practices

3.3.1.1 | Personal Epistemic Practices. Teachers' epistemic practices were assessed using an instrument developed specifically for this study, consisting of two main components: personal epistemic practices and teaching epistemic practices. Personal epistemic practices were measured using three items (PEP1–PEP3) that assessed how frequently teachers engage in source evaluation behaviours: checking authorship and sources (PEP1), evaluating expert credibility (PEP2) and considering scientific consensus (PEP3). The Epistemic PEP subscale demonstrated excellent internal consistency ($\alpha = 0.83$, $\omega = 0.84$).

3.3.1.2 | Teaching Epistemic Practices. Teaching epistemic practices were measured using five items: one item assessing classroom discussion of different scientific views (TEP1: 'How often do you discuss in classroom different scientific views on a topic?') and four items assessing how often teachers have opportunities within their curriculum to discuss with their students: different alternative theories for an issue (TEP2), trust in science (TEP3), the scientific method of producing knowledge (TEP4) and the epistemology of knowledge, such as examples of revision of knowledge (TEP5). The Epistemic TEP subscale, consisting of the four curricular items, also showed excellent internal consistency ($\alpha = 0.86$, $\omega = 0.865$). All items were rated on a 6-point frequency scale (1 = Never, 2 = Very few times, 3 = A few times, 4 = Several times, 5 = Very often, 6 = Always).

3.3.2 | Confirmatory Factor Analysis and Internal Consistency Measures for a Two-Dimension Model With PEP1-3 and TEP1-4

Confirmatory factor analysis for PEP1–PEP3 and TEP1–TEP5 showed excellent fit indices (CFI = 0.999, TLI = 0.997, RMSEA = 0.046, SRMR = 0.036), confirming the two-factor model. Internal consistency was assessed using coefficient omega (ω) and coefficient alpha (α). For the first dimension, $\omega = 0.84$ and $\alpha = 0.83$, and for the second dimension, $\omega = 0.87$ and $\alpha = 0.86$, indicating good reliability for both dimensions. The Kaiser-Meyer-Olkin measure verified the sampling adequacy (KMO = 0.81). Bartlett's test of sphericity indicated that correlations between items were sufficiently large for factor analysis, χ^2 (df not provided) < 0.001.

3.4 | Qualitative Data Collection

A semi-structured interview protocol was developed to explore teachers' experiences and perspectives following their participation in the 'Pro-Me-ToM' training program and subsequent implementation of argument-based pedagogical approaches. The protocol (see Appendix S1) comprised five thematic sections, as detailed in Table 4.

3.5 | Professional Development Program

A professional development program was developed for the purposes of the present study, focusing on promoting teachers' Metacognitive, Theory of Mind and Epistemic beliefs and practices. The program was developed in the context of the Pro-Me-ToM program (see Appendix S1). The professional development materials were first produced in English, translated into the respective languages and delivered by the researchers, who are co-authors of this study. All researchers followed a standardised delivery protocol. In Cyprus and Greece, the professional development was delivered in Greek, the shared language of both countries.

Two of the program sessions focused on promoting teachers' epistemic thinking and epistemic practices, particularly through argumentation. Teachers were introduced to the fundamental concepts of epistemic cognition, including its role in learning and reasoning, supported by current research evidence. The training emphasised the developmental aspects of epistemic understanding, particularly how individuals come to comprehend the role of evidence evaluation in knowledge construction. Teachers explored research findings demonstrating the effectiveness of various interventions in promoting epistemic cognition development, with particular attention to the impact of dialogic argumentation. The program provided concrete instructional strategies designed to foster students' epistemic cognition through structured argumentative discussions and reflective evaluation activities. Teachers were encouraged to implement three key epistemic practices in their classrooms: facilitating dialogic argumentation among students, explicitly teaching the scientific method and its reliability through systematic verification processes and engaging students in critical source evaluation activities using diverse materials ranging from social media posts to scientific publications. Special emphasis was placed on understanding the scientific method's system of checks as a systematic approach to aligning theory with evidence (Oreskes 2019), supporting students' epistemic understanding of why scientific research—and the evidence generated through it—is trustworthy. To support implementation, teachers were introduced to the 'Argue with Me' curriculum (Iordanou and Rapanta 2021) as an example of an argument-based intervention that can be implemented in their classroom to promote their students' epistemic beliefs and practices.

3.6 | Procedure

3.6.1 | Participant Recruitment

Ethical clearance was obtained from the Cyprus National Bioethics Commit and respective local ethical committees in each participating country. A multi-country recruitment

TABLE 4 | Semi-structured interview protocol sections and sample questions.

Section	Focus	Sample questions
Implementation Experiences	Application of argument-based practices, observed student changes and implementation challenges	'Describe how you applied the pedagogical practice of argumentation in your classroom'. 'Do you believe this educational intervention brought about any change in how your students think regarding knowledge production?'
Current Educational Practices	Current state of argumentation education and its implementation in schools	'Do you believe that the education students are now receiving at schools prepares them to develop argumentation skills needed as citizens of a democratic polity?'
Professional Background	Prior training and education in dialogue and argumentation-based approaches	'Were you taught in the context of your university studies about educational approaches based on dialogue and argumentation?'
Future Recommendations	Suggestions for enhancing dialogue, argumentation and critical thinking practices	'Do you have any suggestions regarding how practices for the enhancement of dialogue and argument skill can be applied in schools?'
Educational Policy Context	Broader policy issues affecting implementation	'To what extent do Analytical Programs predict the development of metacognitive skills and argument skill?' 'To what extent does the educational unit take part in shaping educational policy?'

Note: The protocol allowed for follow-up questions and clarifications within each section.

strategy was implemented across Cyprus, Greece, Hungary and Romania, with each nation employing context-appropriate dissemination methods through their respective educational authorities (see Appendix S1).

3.6.2 | Professional Training Program

Over three months, teachers completed twelve 90-min online training sessions in the afternoons, outside school hours. Then, the teachers were encouraged to implement in their teaching, alongside the program, the practices introduced for promoting their students' metacognitive and epistemic thinking, such as Argumentation. The delivery of the program and teachers' application in the classroom took place between Spring 2023 and Spring 2024. After taking part in the program and applying the epistemic teaching practices it encouraged, the teachers were invited to participate in interviews to discuss their experiences and views. In the present study, we focus on six teachers who implemented Argumentation in their classrooms in Greece and Cyprus.

Semi-structured interviews were used to collect data. The interviews were conducted online, in Greek, on an individual basis and were scheduled at a time that was convenient for each teacher. The audio recordings of the interviews, each lasting approximately 20 min, were transcribed verbatim. Once the transcriptions were completed, the interview transcripts were analysed thematically in accordance with Braun and Clarke's (2006) thematic analysis framework, which consists of six phases. The analysis involved collaborative coding between two authors (Iordanou and Georgiou), with regular discussions to align interpretations and joint decision-making on code development and theme construction. First, the transcripts were read and re-read by both researchers to gain familiarity with the data and initial ideas were jotted down. Next, initial codes were generated by identifying meaningful features of the data and assigning codes to these segments. An inductive, data-driven approach was followed, allowing the codes and themes to emerge directly from the data while remaining aligned with the research aims. Subsequently, related codes were grouped together through joint discussion to identify potential themes that were in line with the research aims. Then, the themes were reviewed and refined collaboratively by comparing them against the entire set of interview data to ensure they accurately reflected the participants' responses. Afterward, each theme was defined and named through consensus, with a clear articulation of what each theme represented and an appropriate label assigned to it. Finally, the report was written, presenting a coherent narrative of the analysis. Throughout the process, each phase was iterative, allowing for ongoing refinement of the analysis through continued collaboration between the researchers.

4 | Results

4.1 | Quantitative Analysis

4.1.1 | Teachers' Personal and Teaching Epistemic Practices

Teachers overall reported moderate to high engagement in epistemic practices, with higher frequency in personal epistemic practices compared to teaching epistemic practices (see Table 5). On a 6-point scale (1 = Never to 6 = Always), teachers reported engaging in personal epistemic practices (PEP1–3) between 'several times' and 'very often' ($M = 4.62$, SD = 0.93). Teaching epistemic practices

TABLE 5 | Descriptive statistics for teachers' personal and teaching epistemic practices.

Measure	Description	*M*	SD	Range
Personal Epistemic Practices				
PEP1	Checking authorship and sources	4.90	1.09	2–6
PEP2	Evaluating expert credibility	4.57	1.11	1–6
PEP3	Considering scientific consensus	4.39	1.05	1–6
Teaching Epistemic Practices				
TEP1	Classroom discussion of scientific views	4.27	0.90	1–6
TEP2	Discussion of alternative theories	3.53	1.09	1–6
TEP3	Discussion about trust in science	3.81	1.21	1–6
TEP4	Discussion about scientific method	3.59	1.27	1–6
TEP5	Discussion about epistemology	3.36	1.26	1–6

Note: Scale: 1 = Never, 2 = Very few times, 3 = A few times, 4 = Several times, 5 = Very often, 6 = Always.

(TEP1–TEP4) were reported less frequently, occurring between 'a few times' and 'several times' ($M = 3.57$, SD = 1.01).

To examine a possible relationship between teachers' Personal Epistemic Practices (PEP1–3) and their Teaching Epistemic Practices (TEP1–5), a Spearman's correlation was conducted. A statistically significant positive correlation was found between PEP1–3 and TEP1–5, rs(316) = 0.349, $p < 0.001$. The linear regression model was also statistically significant $F(1,316) = 46.80$, $p < 0.001$, $R^2 = 0.126$, with PEP1–3 significantly predicting TEP1–5TEP1, $b = 0.390$, $t = 6.841$, $p < 0.001$. Although the model residuals test of normality narrowly rejected normality ($W = 0.99$, $p = 0.042$), the small skewness value (−0.32) and its z-score (−2.1), together with the very small kurtosis value (−0.003) and its z-score (−0.01), as well as the QQ plots, justified assuming normality of the residuals.

4.1.2 | Cultural Differences in Teachers' Personal and Teaching Epistemic Practices

To examine cultural differences between countries (Greece, Cyprus, Romania and Hungary) in epistemic practices, we conducted Kruskal–Wallis tests followed by pairwise comparisons with Bonferroni corrections.

4.1.2.1 | **Personal Epistemic Practices.** Analysis of teachers' personal epistemic practices (PEP1–PEP3) revealed significant cross-country differences ($p < 0.001$). As seen in Tables 6 and 7, Greek and Cypriot teachers reported significantly higher engagement in source evaluation practices compared to Romanian and Hungarian teachers. Greece and Cyprus did not differ significantly, and both scored significantly higher than Romania and Hungary ($ps < 0.001$). Greek and Cypriot teachers reported more frequent checking of source authorship (PEP1), evaluation of expert credibility (PEP2) and consideration of scientific consensus (PEP3).

4.1.2.2 | **Teaching Epistemic Practices.** Regarding teaching epistemic practices, as seen in Tables 6 and 7, Greek teachers reported the highest frequency of teaching epistemic practices promoting mature epistemic thinking (TEP1–TEP5 composite: $M = 4.01$, SD = 1.13), followed by Cypriot teachers ($M = 3.60$, SD = 1.07), who showed significantly higher frequency than both Romanian ($M = 3.36$, SD = 0.92) and Hungarian teachers ($M = 3.41$, SD = 0.80), with the latter two showing comparable frequencies.

Analysis of specific teaching epistemic practices revealed distinct patterns across countries. Regarding discussions about the scientific method (TEP), Greek and Cypriot teachers reported similar frequencies ($M = 4.06$, SD = 1.33 and $M = 3.69$, SD = 1.25, respectively), both significantly higher than Romanian ($M = 3.32$, SD = 1.17) and Hungarian teachers ($M = 3.42$, SD = 1.26), who did not differ from each other. Regarding discussing alternative theories in the classroom (TEP1), Greek teachers reported the highest frequency ($M = 4.01$), significantly higher than Cypriot teachers ($M = 3.63$), who in turn reported significantly more frequent opportunities than both Romanian ($M = 3.26$) and Hungarian teachers ($M = 3.36$). Regarding discussions about trust in science (TEP2), Greek teachers reported significantly higher frequency ($M = 4.19$) compared to all other countries, while Cypriot ($M = 3.73$, SD = 1.27), Romanian ($M = 3.76$, SD = 1.18) and Hungarian teachers ($M = 3.54$) reported similar frequencies. Similarly, regarding discussions about the epistemology of knowledge (TEP4), Greek teachers ($M = 3.79$, SD = 1.42) reported significantly higher frequency than all other groups. However, in this case, Cypriot teachers ($M = 3.37$, SD = 1.27) reported higher frequency than Romanian teachers ($M = 3.10$, SD = 1.16), while Hungarian teachers' frequency ($M = 3.32$, SD = 1.07) did not differ significantly from either Cypriot or Romanian teachers.

4.2 | Qualitative Analysis

The following thematic structure presents a progression from classroom-level practices to teacher development and broader institutional considerations. It is organised into four overarching groupings: *Teaching Epistemic Practices*, *Student Learning and Epistemic Development*, *Challenges and Professional Learning* and *Institutional and Policy Reflections*. While certain recurring issues, such as teacher preparation, curriculum constraints and the role of critical thinking, appear across multiple

TABLE 6 | Personal and teaching epistemic practices by country.

Measure	Greece ($n = 68$)	Cyprus ($n = 81$)	Romania ($n = 110$)	Hungary ($n = 59$)
Personal Epistemic Practices (Checking Sources)				
PEP1: Checking authorship and sources when reading articles	5.37 (0.81)[a]	5.33 (0.89)[a]	4.71 (1.19)***[b]	4.14 (0.90)***[c]
PEP2: Evaluating expert credibility for trustworthiness	5.18 (0.83)[a]	4.94 (1.02)[a]	4.30 (1.06)***[b]	3.85 (1.03)***[c]
PEP3: Considering scientific consensus for decision-making	4.88 (0.82)[a]	4.84 (0.81)[a]	4.03 (1.12)***[b]	3.88 (0.95)***[b]
PEP1–3 Composite: Overall personal epistemic practices	5.14 (0.64)[a]	5.04 (0.73)[a]	4.35 (0.96)***[b]	3.95 (0.82)***[c]
Teaching Epistemic Practices (Classroom Implementation)				
TEP1: Classroom discussion of different scientific views	4.32 (0.89)	4.28 (0.91)	4.25 (0.88)	4.21 (0.93)
TEP2: Different alternative theories for an issue	4.01 (1.09)[a]	3.63 (1.10)*[b]	3.26 (1.02)***[c]	3.36 (1.05)***[c]
TEP3: Trust in science	4.19 (1.22)[a]	3.73 (1.27)**[b]	3.76 (1.18)**[b]	3.54 (1.12)**[b]
TEP4: Scientific method of producing knowledge	4.06 (1.33)[a]	3.69 (1.25)[a]	3.32 (1.17)***[b]	3.42 (1.26)***[b]
TEP5: Epistemology of knowledge (e.g., knowledge revision)	3.79 (1.42)[a]	3.37 (1.27)*[b]	3.10 (1.16)***[c]	3.32 (1.07)**[b,c]
TEP1–5 Composite: Overall teaching epistemic practices	4.01 (1.13)[a]	3.60 (1.07)**[b]	3.36 (0.92)***[c]	3.41 (0.80)***[c]

Note: Values represent *M*(SD). Asterisks indicate significant differences from Greece based on Bonferroni-corrected pairwise comparisons: *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. Different superscript letters within the same row indicate significant differences between all other countries at $p < 0.05$. Scale: 1 = Never, 2 = Very few times, 3 = A few times, 4 = Several times, 5 = Very often, 6 = Always.

themes, they are analytically distinguished according to their specific function and context. For example, teacher training is examined both as a limitation in initial preparation and as a source of professional growth (Theme 4), while curriculum reform features in discussions of both systemic change (Theme 6) and future implementation strategies (Theme 7). The structure begins with Theme 1, which addresses teachers' personal and teaching epistemic practices (Research Question 1). Overall, this structure was developed to illuminate how such practices emerge in the classroom and professional learning, as well as the institutional and cultural factors that support or constrain these practices, particularly within the educational cultures of Greece and Cyprus.

4.3 | Teachers' Epistemic Practices: Personal and Teaching Epistemic Practices

4.3.1 | Theme 1: Teachers' Personal and Teaching Epistemic Practices

This theme explores how teachers conceptualise and enact epistemic engagement in two domains: their own personal epistemic practices and their instructional approaches to fostering epistemic thinking in students. While the teachers rarely used explicit epistemic language, their reflections illuminate how they navigate and promote ideas of knowledge credibility, justification and critical engagement, both personally and professionally. This theme directly informs Research Question 1.

4.3.1.1 | Teaching Epistemic Practices

4.3.1.1.1 | Teacher-Directed Argumentation. Teachers mentioned using teacher-guided questioning, usually stimulated by a text, to develop students' reasoning. Teacher 2 described how her students engaged in argumentation both after reading texts and after watching videos, combining interpretation with oral discussion. Teacher 3 described embedding argumentation in her regular questioning practices, especially in theoretical subjects like History, Greek Language and Religious Studies. She views teacher questioning itself as a form of argumentation, enabling students to develop critical thinking through both oral and written justification of their views. While Teacher 3 considers argumentation particularly relevant to theoretical subjects, other teachers, especially those in primary education, saw it as applicable across subject areas. Teacher 1 made it a deliberate daily practice, explaining, 'I made sure that there was an activity every day that had this goal [argumentation]', demonstrating her commitment to using argumentation as an everyday tool for cultivating reasoning.

4.3.1.1.2 | Language-Focused Argumentation. Some teachers viewed argumentation as teaching the structure of an argument and using appropriate language. In particular,

TABLE 7 | g Hedges corrected effect sizes for Personal and Teaching Epistemic Practices comparisons by Country.

Measure	Greece–Cyprus	Greece–Romania	Greece–Hungary	Cyprus–Romania	Cyprus–Hungary	Romania–Hungary
Personal Epistemic Practices (Checking Sources)						
PEP1: Checking authorship and sources when reading articles	0.047	0.622**	1.442***	0.578**	1.331***	0.519**
PEP2: Evaluating expert credibility for trustworthiness	0.256	0.899***	1.433***	0.613***	1.064***	0.429*
PEP3: Considering scientific consensus for decision-making	0.049	0.837***	1.133***	0.810***	1.101***	0.141
PEP1–3 Composite: Overall personal epistemic practices	0.145	0.927***	1.632***	0.793***	1.417***	0.438*
Teaching Epistemic Practices (Classroom Implementation)						
TEP1: Classroom discussion of different scientific views	0.044	0.079	0.121	0.034	0.076	0.045
TEP2: Different alternative theories for an issue	0.347	0.716***	0.607**	0.351	0.250	0.097
TEP3: Trust in science	0.369	0.360	0.553**	0.025	0.157	0.190
TEP4: Scientific method of producing knowledge	0.287	0.600**	0.493*	0.307	0.215	0.083
TEP5: Epistemology of knowledge (e.g., knowledge revision)	0.313	0.545**	0.370	0.224	0.042	0.195
TEP1–5 Composite: Overall teaching epistemic practices	0.373	0.646***	0.606**	0.243	0.197	0.057

Note: Values represent g Hedges corrected values for Cohen d. Asterisks indicate significant differences between pairs of countries based on Bonferroni-corrected pairwise comparisons: *$p < 0.05$, **$p < 0.01$, ***$p < 0.00$.

Teachers 2 and 5, both language specialists, guided students in constructing arguments using structural models, showing for example claims, supporting reasons, and conclusions and emphasised appropriate linguistic expression. She highlighted that student performance was evaluated not only on how well they applied the guided structure, but also on their effective use of language and non-verbal cues such as body language. Teacher 5 reported using essay structuring as a means of helping students formulate and develop arguments independently, providing them with a structured space to apply reasoning and evidence to written claims.

4.3.1.1.3 | Encouragement of Justification. Across the interviews, justification emerged as a core component of teachers' instruction. Teachers 4 and 5 both stressed that students should not merely express opinions but be able to support them with reasoned argument. Teacher 4 explained that students were frequently asked to justify their interpretations: 'Why do I think this? What would happen in the opposite case? How else could we have said it and justified it?' These strategies, she emphasised, were central to developing students' understanding that 'nothing is accepted uncritically' in science. For Teacher 4, this was especially critical in science education, where she argued that a successful lesson should result in students who can 'think and argue' about the knowledge they acquire. Likewise, Teacher 5 explained that in her classroom, 'we never accept things without questioning and always argue our position', reflecting a deliberate effort to normalise justification as an academic expectation.

4.3.1.1.4 | Active Learning, Metacognitive Development and Reflection. Several teachers reported encouraging students to become more reflective learners to foster their metacognitive development. Teacher 1 described how she systematically integrated metacognitive reflection into her daily instruction, stating, 'The truth is that I applied metacognitive reflection very systematically'. She also emphasised that this required a shift in mindset, describing it as 'a different perspective, to learn to reflect on yourself'. Teacher 4 similarly connected her teaching philosophy to the goal of supporting metacognition, especially in science, where students were guided to rethink and refine their understanding in light of new evidence or reasoning.

4.3.1.1.5 | Applied Inquiry-Based Learning. Many teachers reported using inquiry-based strategies

and emphasising the importance of applying knowledge. Teachers 3, 5 and 6 all described using inquiry-based strategies to promote epistemic engagement. These included designing lessons around open-ended questions, encouraging students to investigate alternative explanations and fostering a culture of sustained questioning. Teacher 5's approach was directly informed by curriculum reforms, which she described as 'based exactly on this: argumentation and investigation'. Teacher 4 consistently emphasised that the goal of science instruction is not merely the transmission of content but the development of students' ability to apply knowledge in meaningful ways. She explained that a science lesson is considered successful when children have learned to 'think and argue'. She also rejects what she calls 'flat' teaching, i.e., approaches that prioritise low-level recall and factual memorization.

4.3.1.1.6 | Collaborative Learning. Collaborative, peer-based learning featured prominently in the accounts of Teachers 2, 5 and 6. They structured group activities that allowed students to discuss, negotiate and co-construct arguments. Teacher 2 emphasised collaborative work in which students' generated arguments both for and against a given position, refining their reasoning through discussion and interaction.

4.3.1.1.7 | Modelling and Scaffolding Toward Independent Reasoning. Teachers 1, 2 and 4 described how they modelled and scaffolded epistemic engagement in their classrooms through their teaching epistemic practices by initially supporting them and gradually relinquishing support to encourage autonomous learning. Teacher 2 initially provided students with explicit instruction in argument structure, but later gave them more freedom in organising and articulating their claims. Teacher 1 described how she adapted her textbook materials to meet her students' interests and cognitive levels: 'You take parts of the textbook and create your own material and activities, which suit the level, wishes and interests of the children'. This adaptive practice helped her create accessible entry points for argumentation while still encouraging students to take ownership of their thinking.

4.3.1.1.8 | Navigating Traditional Constraints. While committed to implementing more progressive, student-centred pedagogies, several teachers admitted that their school environments remained predominantly teacher-centred. For example, Teacher 6 reported being surprised that the pedagogical practice introduced by the intervention contrasted significantly with the typical 'teacher-centred' practices used in his school. Teacher 1 similarly remarked that 'us teachers do everything for students, and the students don't do anything', reflecting a perception of deeply rooted traditional expectations about teacher authority and student passivity. This highlighted the broader contrast between conventional school structures and efforts to implement inquiry-driven, epistemically rich instruction.

The findings suggest that, while the depth and form of teaching epistemic practices vary, the participating teachers shared a commitment to developing students' epistemic practices. Teachers reported using the epistemic practice of argumentation prior to the professional development program, but in a different way—as a teacher-directed, language-focused practice rather than the peer-centred, dialogic argumentation approach of the 'Argue with Me' program that was introduced during the professional development.

4.4 | Personal Epistemic Practices: Evaluating Sources and Credibility

Although most teachers focused on their instructional roles, some reflected on how they personally approach knowledge evaluation. These reflections, while limited, revealed attention to the credibility of information, the need for evidence and the careful scrutiny of sources.

Teacher 6 described being cautious about the reliability of information he uses in class preparation: 'Where should I look for information to verify if what I'm saying is true? I shouldn't say something that, for example, is a distortion of the facts'. This statement reflects a personal norm of verifying the reliability of information before using it instructionally, an epistemic habit aligned with source-checking and credibility assessment.

Though these accounts were not the primary focus of the interviews, they suggest that some teachers personally engage in epistemic practices such as evaluating source credibility, seeking justification and rethinking interpretive approaches in their own professional contexts. These findings provide some complementary insights to the quantitative findings addressing Research Question 1 about teachers' self-reported personal and teaching epistemic practices.

4.5 | Student Learning and Epistemic Development

4.5.1 | Theme 2: Development of Students' Epistemic Practices Through Engagement in Dialogic Argumentation

The teachers consistently observed that the implementation of argumentation-based activities led to important changes in how students engaged with knowledge. This shift was reflected in acquiring epistemic practices which are not typical of school norms, particularly within the traditionally teacher-centred educational cultures of Greece and Cyprus, which prioritise teacher authority and factual recall over dialogic or inquiry-based learning. Teachers reported a change in students' epistemic practices from passively consuming knowledge to evaluating sources, justifying claims with evidence, considering multiple perspectives and constructing structured arguments.

4.5.1.1 | From Passive Acceptance to Epistemic Evaluation of Sources. Several teachers noted that students began to question the credibility of information, especially from online sources, reflecting a shift toward epistemic evaluation, that is, the ability to assess the reliability of information and its origins. As Teacher 1 stated, 'We also explained what a source is, what a source means for information', which helped lay the groundwork

for students to begin thinking more critically about the origins of the information they use.

Teacher 3 provided one of the clearest examples of this development, describing how her students 'started wondering who said it, who wrote it' and began 'questioning various things to see if something was reliable'. Her account shows that students were not merely reacting to content but were actively questioning the trustworthiness of its source.

Teachers' facilitation of such conversations reflects their own appreciation of encouraging epistemic discussions, such as about the credibility of the source of knowledge, after their engagement in the professional development program.

4.5.1.2 | Developing an Appreciation for the Role of Evidence. The teachers noted that students began to recognise that claims need justification, marking an important shift toward epistemically justified reasoning. Teacher 4 noted that students learned not to accept information uncritically, but rather to 'question, investigate, reflect...(on) knowledge on their own', signalling awareness of the need to assess the grounds of knowledge claims. Teacher 5 described how students became more intentional in their reasoning: 'they were looking for it from there... They were asking, "How will we support this, and where does it lead us?"' Similarly, Teacher 2 noted that engagement in argumentation helped students realise that substantiating claims requires more than simply stating an opinion: 'made them realize... That it's not just about that, it requires... More details, more substantiation.' This development suggested that students were learning to interrogate not only the content of knowledge claims, but the basis on which they were made. The move from uncritical acceptance of information to an expectation of evidence-based justification constitutes a significant progression in students' epistemic agency.

4.5.1.3 | Gains in Epistemic Understanding: Appreciating Multiple Perspectives. Through argumentation, students became more attuned to the idea that knowledge is not fixed but can be interpreted in different ways, depending on one's perspective. The teachers intimated that the argumentation practices encouraged students to engage with diverse perspectives—an essential aspect of epistemic understanding. Teacher 6 emphasised how the activities helped students think beyond the textbook by asking themselves 'Is there anything else I can think of and argue about on this?', suggesting a growing capacity to explore multiple perspectives and move beyond accepting ready-made answers. Teacher 2 noted that after the professional development she designed tasks that encouraged students to reflect on differing viewpoints: 'I added more tasks where the students...would show what they gained and how they managed to put themselves in the other's shoes', suggesting an interconnection between changes in teachers' epistemic teaching practices and their students' epistemic practices.

4.5.1.4 | Gains in Students' Argumentation Skills. A central theme across the teachers' reflections was students' gains in constructing coherent, well-organised arguments. This development reflects a shift toward more epistemically grounded communication. Teacher 2 observed that students began to consistently include structured components such as introductions, explanations and supporting evidence in their oral and written arguments. Teacher 5 similarly observed that students became more adept at organising their thoughts in a coherent manner, whether speaking or writing. These developments were fostered through teachers' deliberate scaffolding of argumentative reasoning. The instructional emphasis on coherence and justification illustrates teaching epistemic practices that support students in applying the structure and logic of scientific argumentation.

4.5.2 | Gains in Students' Social and Communication Skills Through Argumentation Activities

Teachers highlighted gains in students' social and communication skills from their engagement in argumentation activities, in addition to gains observed in argument skills per se. Below, we present the gains in students' social and communication skills resulting from their engagement in argumentation-based activities.

4.5.2.1 | Enhanced Collaborative Skills. The intervention fostered students' ability to engage in constructive dialogue and collaborate more effectively. Teacher 1 explained that the collaborative nature of the activities helped students to reason together and engage in mutual reflection: 'It helped a lot in making it happen because those activities made them collaborate, exchange opinions within the group.' This suggests that engagement in dialogic argumentation with peers facilitated epistemic engagement and promoted epistemic reflection.

4.5.2.2 | Development of Listening and Turn-Taking Skills. Teacher 5 noted that the intervention helped students improve their listening skills. Rather than merely waiting for a chance to speak, students learned to listen actively and engage with what others were saying. Teacher 6 noted that students began respecting others' speaking time: 'One child had to wait for the other to speak... usually the child expects only the teacher to speak'. These shifts from monologic to dialogic exchange reflect improved communication skills and a growing sensitivity to epistemic norms, acknowledging the value of others' perspectives and grounding one's own claims in shared dialogue.

4.6 | Implementation Challenges

4.6.1 | Theme 3: Difficulties Encountered by Teachers in Implementing Argumentation-Based Practices

This theme directly addresses the second part of Research Question 4, which concerns the challenges reported by teachers in implementing the 'Argue With Me' curriculum. While the teachers recognised the value of argumentation-based practices, they also encountered various challenges in their implementation. These challenges included classroom management, curriculum pressure, student disengagement and difficulties in promoting certain epistemic norms such as evidence-based reasoning and source evaluation. The obstacles teachers described

reveal not only structural constraints but also the epistemic demands that argumentation places on both students and teachers.

4.6.1.1 | Challenges Related to Students' Epistemic Beliefs and Engagement. The teachers reported that some students struggled with the idea that knowledge is open to interpretation or debate, particularly in subjects traditionally perceived as fact-based, such as science. These difficulties suggest a tension between the teaching epistemic practice of introducing the revisable nature of knowledge and students' prior beliefs that knowledge is fixed and non-negotiable. As a characteristic example, Teacher 4 noted facing challenges at the beginning of the intervention due to students' confusion about having debates in a physics class: 'They couldn't understand if this had any significance and what connection it might have with physics.' She explained that students were not accustomed to treating science as a domain requiring reasoning and justification, but rather as a body of static facts to be memorised. However, after the initial stage, students became more cooperative and engaged in the activities: 'After the interventions, all the children were very cooperative'.

4.6.1.2 | Challenges in Supporting Source Evaluation and Justification. The teachers also described difficulties in fostering students' ability to evaluate sources and justify claims, core components of their teaching epistemic practices. Teacher 5 described difficulties in encouraging students to move beyond brief, fragmented responses: 'The difficulties I mainly faced were in getting them into the process of discussing and arguing'. He further noted: 'Because the children haven't learned this. Even when we ask them something, the answer is yes, no, I agree, I disagree, or they respond with just one word'. This response suggests that students were unfamiliar not only with the norms of justification but also with how to express those justifications in coherent, extended discourse, skills that require both epistemic and communicative support. Meanwhile, Teacher 6 observed that one of the most persistent issues was helping students assess the credibility of information they encountered: 'The problem that arose had to do with the source of information. That's where we got stuck'. His reflection indicates the instructional challenge of modelling and supporting epistemic norms related to source credibility and evidence use.

4.6.1.3 | Constraints of Class Size and Curriculum. Several teachers mentioned structural constraints that made it difficult to create space for epistemically rich classroom discourse. Teacher 6 noted: 'One of the reasons is that there are too many students. It's not feasible to think that we can have, for example, 24 students in a class engaging in dialogue'. Additionally, he emphasised how curriculum pressure often pushed argumentation to the margins: 'The teacher is trying to cover the curriculum... That's what they are judged on'. These reflections reveal how systemic constraints can undermine teaching epistemic practices such as encouraging discussion of competing scientific views or allocating time for the development of argument construction. These reflections address Research Question 4, particularly part (a), as they highlight the practical challenges teachers encountered in implementing argumentative practices. They also help unpack part (c), offering insight into how these challenges shaped their professional development, revealing both the constraints and the pedagogical adjustments required to promote epistemic and dialogic engagement.

4.7 | Teachers' Gains From the Professional Development Program and Reflections on Their Higher Education

4.7.1 | Theme 4: Benefits for Teachers From Professional Training & Reflection on Teacher Education

The teachers experienced a range of positive outcomes stemming from professional training in supporting students' argumentation skills, particularly in terms of enhancing their own reflective practices and refining their ability to guide students in developing critical thinking and argumentation skills. The teachers reported that the training not only provided them with effective strategies for integrating argumentation into their lessons but also encouraged deeper reflection on their teaching methods and approaches to student engagement. Importantly, several teachers described changes in how they understood their teaching role, especially in fostering epistemic engagement, which reflects a broader development in their epistemic beliefs and teaching practices. For example, Teacher 2 emphasised how the training prompted her to design activities aimed at developing students' metacognitive skills, enabling them to think critically and consider multiple perspectives: 'I added more tasks where the students... would show what they gained and how they managed to put themselves in the other's shoes'. These training sessions prompted her to reflect deeply on her teaching methods and adapt them in ways that would be conducive to students' understanding of 'the learning process' and encourage their engagement in reflective thinking.

The impact of the training was also evident in Teacher 5's history lessons. She shared that the strategies she learned enabled her to help students analyse historical sources from multiple perspectives, encouraging them to question and engage with the material in a more critical way: 'It has helped me a lot in history as well, especially in processing sources, which is something that really challenges the students'. She expressed that the training she received fundamentally changed how she approached sources in general, especially in helping students understand that history is interpreted differently depending on perspective.

Overall, both Teacher 2 and Teacher 5 experienced a marked transformation in their teaching epistemic practices following the training. They became more adept at fostering critical thinking, dialogue and argumentation skills in their student and felt more confident supporting students in engaging with content from multiple perspectives. The training equipped them with both practical tools and the theoretical foundation necessary to integrate these skills more effectively into their classrooms, resulting in more reflective and impactful teaching.

4.7.1.1 | Teachers' Acknowledgment of Insufficient Training in Argumentative Pedagogical Approaches. Upon being asked about the training they received in argumentation-based pedagogical approaches during their university studies, many teachers reported that

the preparation they received was either superficial or not aligned with the practical needs of fostering critical thinking and argumentation in the classroom.

Teacher 2 recalled that her early university education touched on instructional models but offered little depth in argumentative practices or metacognitive reflection. This limited preparation hindered her ability to effectively implement argumentation practices in her classroom. It was only later, through self-directed learning and more advanced studies, such as her master's and doctoral programs, that she gained a better understanding of these pedagogical approaches. Teacher 6 echoed the sentiment that his training was insufficient for teaching argumentation. When asked whether argumentation was addressed during his training, he responded: 'No. Only pedagogical theories, generally and vaguely'. His use of the phrase 'generally' and 'vaguely' points to a recurring disconnect between abstract pedagogical concepts and the practical instructional strategies needed to teach students how to reason, justify and engage in dialogue.

Overall, teachers' acknowledgment of insufficient preparation in their higher education suggests that the professional development provided in this program played a compensatory role, bridging an important gap in their preparation and supporting long-term professional growth. Addressing research question 4, their accounts point to a broader need for teacher education programs to better equip educators with the epistemic and pedagogical tools required for implementing effective epistemic teaching practices, including argumentation.

4.8 | Institutional and Policy Reflections

4.8.1 | Theme 5: Strengthening Institutional Management and Reform for Argumentation-Based Pedagogy

A common theme across the teachers' perspectives on educational reform revolves around the need to restructure both school administration and the curriculum in ways that foster more effective teaching that supports critical thinking and student engagement. Their reflections went beyond the classroom to include recommendations for curriculum design, school leadership, assessment policy, teacher training and even national education governance. There is a clear call for changes in how teachers are supported and evaluated, as well as in the broader infrastructure that underpins teaching and learning.

4.9 | School Administration and Curriculum

Many teachers advocate for a shift toward a more dynamic, student-centered curriculum that encourages critical thinking and active learning. Teacher 1, for instance, underscores the importance of incorporating argumentation and inquiry-based methods into the curriculum, citing recent reforms aimed at enhancing these skills. She notes that the current curriculum does not sufficiently incorporate argumentation, a gap that the new syllabus aims to address: 'Yes, I will say that because I have been trained in the new curriculum programs. In the new curriculum programs, there is a lot of argumentation. In the existing ones, it's not included as much, to be honest, almost not at all'.

Similarly, Teacher 3 highlights the need for assessments that better evaluate students' critical thinking and argumentation abilities, advocating for open-ended questions that allow teachers to assess students' reasoning rather than rote memorization. She emphasises that the cultivation of these skills should be embedded from an early age, particularly in subjects like language and literature, where students can be encouraged to formulate and defend their opinions. The call for more flexible, dialogue-driven learning environments is echoed by Teacher 5, who stresses the importance of open-ended, opinion-based learning, particularly in subjects like literature. She suggests that this approach should begin as early as middle school and that students should be encouraged to develop critical thinking skills through discussion and debate: 'I believe that what happens in high school with literature should be done here too, where we don't guide the students to answer something specific, but all of literature is based on their own opinions, observations'. These reflections suggest that institutional support for dialogic learning requires alignment between pedagogy, curriculum and assessment, and by extension, stronger support from school-level leadership in facilitating these changes.

4.9.1 | Professional Development and Shared Resources

Alongside curriculum changes, teachers agree on the importance of improving teacher training and professional development to equip educators with the skills needed to implement these reforms effectively. There is a consensus that training should be more targeted and continuous, rather than relying on brief, one-off seminars. Teacher 3 argues for multi-session programs that allow for deeper exploration of teaching methods, particularly those that encourage critical thinking and argumentation. Teacher 5 also highlights the importance of ongoing professional development and suggests that teachers should be supported by a repository of shared resources and activities: 'It would be good to have a repository where there are similar activities from colleagues, whether they are just suggestions or actual applied activities'.

4.9.2 | National-Level Reform and Educational Governance

Teacher 6 expands on this idea by calling for a broader social reform to accompany educational changes. He suggests that educational reforms must align with the country's overall development goals, emphasising that a democratic, collective approach should guide both educational leadership and decision-making: 'Educational reform cannot be disconnected from social reform. That is, we need to have a good standard of living as a country. Positions of responsibility, as I mentioned before, should not be linked to financial rewards. We should all work democratically. We should prioritize the interests of the many'.

Teacher 6 also advocates for improving the quality of school textbooks. He suggests that textbooks should be more engaging and varied, incorporating stimuli such as posters and invitations

that can better capture students' attention. This theme reflects a clear desire for institutional reform that supports the sustained integration of argumentation and critical thinking in education. Teachers' reflections span local, curricular and national levels, calling for alignment between pedagogical goals and systemic structures. These insights complement the classroom-level epistemic practices addressed in earlier themes by drawing attention to the broader educational infrastructure required to sustain such practices.

4.9.3 | Theme 6: The Role of the Educational Unit in Shaping Educational Policy and Suggestions for Policy Reform

In exploring the role of the educational unit in shaping educational policy, while some teachers feel that schools significantly shape educational practices, others see their influence as more limited or symbolic. Many emphasise the need for a more flexible curriculum, earlier introduction of critical thinking skills and greater autonomy for teachers in adapting curriculum to students' needs. Teacher 1 believes her school plays a central role locally in shaping its educational framework but acknowledges limited impact on broader educational policy decisions. Teacher 3 takes a more cautious view noting efforts to include students in decision-making through student councils; however, she feels that the role of students in shaping policy is largely symbolic, rather than substantive: '... the effort here to give voice to the students through the student councils, but I have the sense that the role is symbolic'. She also highlights the disconnect between the school goals and the actual needs of different grade levels. For example, while argumentation may be prioritised in some school units, it is deprioritized for younger students, who may be focusing on other educational goals. She suggests that educational policy should be more responsive to the varying needs of different school levels and involve students more meaningfully in the process. Teacher 4 believes that moving toward inquiry-based teaching and argumentation is essential for developing students' higher-order thinking skills: 'Yes, I believe it is very important for all teachers to move forward at this level of teaching. And as a member of the Scientific Association of Physicists, we make proposals to the Institute of Educational Policy and create topics for the national physics competitions... The method of inquiry, argumentation, so that children can develop higher-level skills'. This involvement gives her a sense that teachers can play a more active role in shaping educational policies that foster critical thinking.

Teacher 2 noted that while broader policies are set by higher authorities, schools have flexibility in implementing the curriculum. She advocates for incorporating debate and critical thinking exercises from an early age and across all subjects: 'The earlier this starts in schools, the better the results will be when students reach the higher grades'. In contrast, Teacher 6 believes that the educational unit has no influence in shaping policy. 'I don't think it has', emphasising a disconnect between schools and policymaking processes.

Despite varied views, many teachers agree on the need for greater autonomy in shaping curricula to address their students' specific needs, acknowledging the need to incorporate critical thinking, debate and argumentation earlier in the curriculum. These insights address Research Question 4 on how teachers reflected on their role in shaping educational practices and policies, showing that while the view is that their system-level influence is limited, they propose an engaged professional stance and a desire for reform that empowers schools and teachers to foster more critical, inquiry-driven learning environments.

4.10 | Theme 7: Future Implementation of Argumentation-Based Practices in Schools

In envisioning the future implementation of argumentation-based practices in schools, several teachers expressed a strong commitment to continuing and expanding these pedagogical approaches. Their perspectives revolve around integrating these practices more deeply into the curriculum, enhancing teacher development and adapting school environments in ways that are conducive to developing critical thinking and argumentation skills. These reflections illuminate the structural, pedagogical and cultural changes teachers consider necessary to sustain the long-term success of argumentation-based learning.

4.10.1 | Extending Argumentation Beyond Language Subjects

Teacher 2 points out that argumentation practices are typically limited to language subjects: 'And also, I believe this occurs only in language lessons'. This observation can be construed as a subtle suggestion of the need for broader integration of these practices across teaching subjects. Teacher 5 shares a similar outlook and advocates for earlier exposure, suggesting that argumentation should be introduced as early as secondary school, or even the final grade of elementary school: 'I think it should start, if not from the sixth grade of elementary school, where their thinking has matured somewhat, then definitely from the first year of secondary school'. This gradual approach, she argues, would allow students to develop argumentation skills more naturally before entering secondary school.

4.10.2 | Strengthening Professional Development and Peer Learning

Aside from early implementation, teachers concur on the importance of sustained and collaborative professional development to ensure educators are equipped to teach argumentation effectively. Teacher 1 advocates for peer-led knowledge exchange: 'I would again suggest that colleagues do such activities with each other, meaning that one school after another should inform and spread the knowledge'. Teacher 3 further supports this idea, highlighting the need for continuous professional development beyond university education. 'We shouldn't stay with what we learned at university, even though many years have passed'. However, she warns that brief professional development sessions may not be sufficient: 'If professional development were applied, even for just 40 min in the workplace, I think that part is missing, and this difficulty would improve'.

These reflections mirror calls emerging from other themes for more substantial, practice-oriented professional learning.

4.10.3 | Curriculum Reform and Assessment Policy

Several teachers mentioned structural constraints, particularly curriculum pressure, as a barrier to embedding argumentation in daily teaching. Teacher 1 calls for curriculum reform that allocates specific time for argumentation without rushing through content: 'The curriculum should allocate time in the lessons for this to happen, so that we don't have the stress of completing the syllabus', she explains, highlighting the need for more flexibility in the curriculum. Teacher 4 envisions changes in the national exams, which would help drive the shift toward argumentation-focused teaching: 'If the topics of the national exams change, automatically, every teacher will need to adjust their teaching to the new mentality'. This view suggests that policy-level changes in assessment could serve as a powerful lever for shifting instructional priorities toward argumentation and critical thinking.

4.10.4 | Cultural Shifts and the Role of School Climate

Beyond curricular and structural shifts, the teachers touch on the importance of cultivating a school culture that values respectful dialogue and epistemic engagement. Teacher 6 describes argumentation as 'an enjoyable activity that helps the group and also benefits the daily teaching routine', but stresses that for argumentation to be truly effective, the broader school culture must reflect these principles. He explains that 'For this to happen, I believe there needs to be an explanation of what is happening at school to all the children', advocating for a school-wide commitment to respectful dialogue. He warns that unless cultural norms shift away from rewarding the loudest voices, reasoned discourse will be undermined: 'What exists is the opposite, that whoever shouts the loudest will get their way'. This perspective raises the need for schools to foster inclusive norms around voice, listening and mutual respect, preconditions for successful implementation of argumentation-based learning. These reflections further inform Research Question 4 by showing how teachers envision building on what they learned in the professional development program. Their proposals suggest that sustaining argumentative practices requires not only pedagogical tools but also supportive curricular, institutional and cultural conditions. The future of argumentation-based pedagogy, in their view, depends on both school-wide commitment and systemic support.

5 | Discussion

The present study investigated teachers' experiences and reflections on implementing argumentative-based epistemic practices in their classrooms, following their engagement in a professional training program aimed at supporting their metacognitive and epistemic teaching practices. We examined teachers' reflections both on their professional development and their students' gains after engaging in argumentative activities. Additionally, we assessed teachers' pre-program self-reported epistemic practices—both personal and teaching—across different cultural contexts, as understanding teachers' existing epistemic beliefs, practices and cultural considerations is crucial for designing effective professional development programs.

The findings regarding teachers' self-reported teaching epistemic practices reveal an interesting gap between personal engagement and classroom implementation. While teachers reported relatively frequent engagement in epistemic practices when learning themselves—particularly in evaluating information—they were less likely to incorporate these same practices into their teaching. This discrepancy suggests that teachers recognise the value of epistemic practices, such as evaluating source credibility and engaging in argumentation for their own learning, but may face challenges in translating these practices into their classroom instruction. The lower frequency of teaching epistemic practices (occurring between 'a few times' and 'several times') points to potential barriers to implementing them in classrooms. The qualitative analysis of teachers' interviews identified their insufficient education on how to implement effective epistemic practices in the classroom, along with the curriculum demands and time constraints, as barriers to implementing teaching epistemic practices that promote students' epistemic beliefs and practices.

In examining the extent to which teachers' personal epistemic practices predict their teaching epistemic practices across different domains, the analysis revealed a significant predictive relationship, with teachers' personal epistemic practices predicting their teaching epistemic practices. Specifically, teachers who reported higher engagement in personal epistemic practices, such as evaluating source credibility and considering scientific consensus, were more likely to implement similar practices in their teaching. This relationship underscores the crucial need to support the development of teachers' own epistemic beliefs and practices in higher education. Given evidence that teachers' own epistemic practices, such as argumentation skills, are closely linked to their teaching epistemic practices and the support they provide to students (Lytzerinou and Iordanou 2020), it is essential that higher education provides opportunities for teachers to develop sophisticated epistemic practices. This could be achieved by engaging preservice teachers in argument-based programs (Iordanou and Constantinou 2014), which support the development of advanced epistemic practices.

Regarding the research question of whether teachers' personal and teaching epistemic practices vary across four European countries, results showed notable cultural differences in both teachers' personal and teaching epistemic practices. Overall, Greek and Cypriot teachers reported higher engagement in epistemic practices compared to their Romanian and Hungarian teachers. The similarity between Greek and Cypriot teachers' practices is unsurprising, given their shared cultural and educational traditions. The differences between Greek and Cypriot teachers and Romanian and Hungarian teachers might be attributed to variations in national education policies, teacher training curricula, professional development opportunities, previous experience with epistemic

or argumentation practices, or broader educational contexts across these countries. These cultural differences align with PISA results revealing cultural differences in epistemic beliefs and practices, such as 15-year-olds' views on whether more than one position can be correct in a disagreement, with Greek students showing the highest agreement (55.7%), followed by Hungarian (46.8%) and Romanian (30.4%) students (OECD 2024). These cross-cultural differences in teachers' epistemic practices suggest that national educational policies, teacher training programs and broader cultural attitudes toward epistemic thinking largely shape teachers' practices. Cross-cultural differences also highlight the importance of considering national contexts when developing teacher training programs aimed at promoting teachers' epistemic practices and suggest that different countries may require tailored approaches to support teachers' epistemic growth.

In examining how teachers perceive the impact of the professional development program on their implementation of argumentative practices, their students' social and communication gains and their own professional growth, several interesting findings emerged. First, teachers reported that the professional development program significantly influenced their implementation of argumentative practices. They noted that the training provided practical strategies for integrating argumentation into their lessons while promoting critical thinking and deeper student engagement. The program encouraged reflection on teaching methods, emphasising the importance of developing students' metacognitive skills and understanding of the learning process. Teachers adapted their practices to guide students in distinguishing arguments from evidence and substantiating opinions effectively, and designed activities that promoted reflection and critical analysis.

Second, teachers observed significant improvements in students' social and communication skills as well as learning, aligning with previous findings (Iordanou et al. 2019; Iordanou and Kuhn 2025; Rapanta 2021). They noted enhanced collaborative activities, active listening and respect for turn-taking, fostering more constructive dialogue. Notably, teachers observed gains in students' understanding of multiple perspectives, which align with findings reported in the literature after students' engagement in sustained dialogic activities (Iordanou 2022b; Iordanou et al. 2025).

Finally, the program contributed substantially to teachers' professional growth, enhancing their ability to foster critical thinking, dialogue and argumentation skills in students. Teachers reported increased confidence in encouraging engagement with diverse perspectives and felt better equipped with both practical tools and theoretical foundations to integrate these practices effectively, leading to more reflective teaching. They also moved from teacher-centered argumentation practices—centered on the teacher who asks questions and students respond—to student-centered practices, where students debate directly without teacher mediation.

A recurring theme across the reflections of the teachers is the insufficient training they received in advanced epistemic practices, particularly argumentation-based pedagogical approaches, during their university studies. Many teachers reported that the preparation they received was either superficial or not aligned with the practical needs of fostering critical thinking and argumentation in the classroom. These findings point to a pressing need for targeted professional development initiatives to bridge these gaps, enabling teachers to better understand and apply argumentation-based teaching strategies in ways that meet the demands of modern education. These initiatives should include structured training programs, workshops and the integration of argumentation principles into pre-service teacher education curricula. Programs like the one implemented in this study—combining exposure to research-informed practices, theoretical and empirical justification, classroom implementation and guided reflection—seem promising for supporting teachers in developing effective epistemic teaching practices.

The findings relating to the theme of *Enhancing Institutional Management in Education* lend themselves to significant implications for school leadership and administration. Specifically, institutional leaders should prioritise curriculum reform that integrates argumentation, critical thinking and student-centered approaches. Teachers emphasise the need for regular integration of these practices across subjects and grade levels to cultivate higher-order thinking. In addition, assessment practices should move beyond standardised models toward open-ended evaluations that emphasise reasoning and critical thinking (Altıntaş 2022; OECD 2023). Collaborating with educators to design such assessments can better reflect the needs of a modern educational landscape (Kennedy-Clark et al. 2017).

5.1 | Policy Recommendations

The findings of the present study carry several important implications for educational policy and institutional management. The apparent disconnect between school-level initiatives and broader educational policymaking processes indicates a need for more robust mechanisms to incorporate teacher voices in policy decisions. There is a need to establish formal channels for regular dialogue between teachers and policymakers, ensuring that curriculum development is informed by frontline teaching experiences. Additionally, while individual teachers may successfully implement teaching epistemic practices in their classrooms, there should be more flexibility, particularly in terms of covering particular content, to enable teachers to implement more student-centered teaching epistemic practices in their classrooms, such as Argumentation. Based on the strong teacher consensus emerging from this study, policymakers and curriculum developers should prioritise the systematic integration of argumentation skills across subjects from early education onwards, supported by appropriate pre-service teacher education and in-service professional development programs. Our findings also underline the need to develop evidence-based policies that support the development of 21st century skills, including the epistemic practices of engaging in fruitful argumentation and evaluating the reliability of the information encountered offline and online. The present study echoes the recommendations of international surveys (e.g., OECD 2024) highlighting the need to support teachers so they, in turn, can better support their studentsa key factor in fostering lifelong learning.

Author Contributions

Kalypso Iordanou: conceptualization, data curation, supervision, formal analysis, writing – original draft, funding acquisition, methodology, writing – review and editing. **Panayiota Metallidou:** funding acquisition, data curation, writing – review and editing. **Plousia Misailidi:** conceptualization, funding acquisition, writing – review and editing, data curation. **Paris Vogazianos:** writing – review and editing, formal analysis, data curation. **Mary Koutselini:** data curation, writing – review and editing, conceptualization, funding acquisition. **Eleonora Papaleontiou-Louca:** data curation, conceptualization, funding acquisition, writing – review and editing, project administration. **Demetra Georgiou:** data curation, formal analysis, writing – review and editing. **István Zsigmond:** funding acquisition, data curation, writing – review and editing. **Ágnes Bálint:** conceptualization, funding acquisition, data curation, writing – review and editing. **Piedade Vaz Rebelo:** funding acquisition, writing – review and editing.

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Ethics Statement

This study has received ethical clearance from the Cyprus National Bioethics Committee.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section. **Appendix S1:** hequ70106-sup-0001-AppendixS1.docx.