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Research article

What is scientific literacy for future science teachers? A comparative study of Türkiye and Sweden

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Abstract: This study has two related aims; to investigate the perspectives of pre-service science teachers from Türkiye and Sweden on scientific literacy including what content is relevant and important and how these perspectives might be related to their future teaching practices. Utilizing the framework of Visions of Scientific Literacy and Curriculum Emphases by Roberts (1998, 2007), the research conducts a comparative analysis to give an overview of how pre-service teachers privilege specific contents that they attributed to science education in terms of "why to teach science" according to their perspectives. The findings reveal that participants from both countries referred to the curriculum emphases, Everyday Coping (EC) and Correct Explanation (CE), as the most important reasons to teach science, whereas Scientific Skills Development (SSD) and Science, Technology, and Decision (STD) were notably underemphasized in both contexts. However, the study also revealed differences in the perspectives of pre-service science teachers. For the pre-service teachers from Türkiye, teaching science was important to deal with daily life issues, whereas the ones from Sweden privileged more scientific facts and processes. Furthermore, participants from both countries problematized science teacher education but in different ways, including teaching evolution, having too few or too many subject courses in the teacher education. This cross-cultural comparison provides insights into how scientific literacy is promoted within diverse educational environments; the results help to reflect on what may be included and excluded in science teacher education and inform possible future improvements within science teacher education.

Keywords: scientific literacy, teacher education, comparative didactics, pre-service science teacher

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1 Introduction

Pre-service science teachers are trained to be prepared for their future roles as teachers in schools. During this training, they develop specific perspectives on the educational content and methods that may inform how science will be taught and learned. These perspectives are likely to play a crucial role in shaping how they plan and implement science instruction in their future classrooms (Zhang et al., 2023). Given the crucial role of science teachers in fostering a scientifically engaged public (Chin 2005), these perspectives are essential for promoting scientific engagement in society.

In addition to teacher education, cultural, economic, and socio-political environments may also play crucial roles in forming future science teachers' perspectives (e.g., Moore,

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2007). Consequently, understanding and comparing the perspectives of pre-service science teachers from different countries can provide crucial insights into science education practices. This study investigates the perspectives of pre-service science teachers from Sweden and Türkiye on scientific literacy in relation to their teacher education and their future teaching. By conducting this cross-cultural comparison, the aim of the study is to investigate similarities and differences in how future teachers articulate scientific literacy in terms of teaching content, subject didactics, and science teacher education.

2 Previous research and theoretical framework

Science teacher education programs hold a significant responsibility for promoting scientific engagement within society, as science teachers play a crucial role in fostering scientific engagement in the classrooms (Chin, 2005) and preparing students to be scientifically literate citizens (Dani, 2009) as the main goal of science education (Osborne, 2023). Before the teachers start teaching science in classrooms, in practicum or as graduate teachers, science teacher education programs serve as foundational platforms where pre-service science teachers learn to plan and implement educational content and manners of teaching in their future science classrooms. Therefore, pre-service science teachers are likely to develop certain perspectives on science education, allowing them to assume that they would plan their future science classes according to these perspectives (Boz & Uzuntiryaki, 2006), such as privileging one content or subject over another (Ates et al., 2025). These perspectives might be directly related to the subject. For example, it is often reported that pre-service science teachers find science confusing or incomprehensible (Velthius et al., 2014). Science teachers also often describe science as deterministic, far from values and fact-based (Özden &Yenice, 2022). These views on science become even more visible for the pre-service science teachers of younger ages (Altun-Yalçın et al., 2011). However, these perspectives might not always be solely connected to what they learn in teacher education (Streller & Bolte, 2018). Therefore, the present study explores pre-service teachers' perspectives on science education by utilizing the Visions of Scientific Literacy and Curriculum Emphases proposed by Roberts (2007). These frameworks offer a thorough insight into the significance that pre-service science teachers attribute to different goals of teaching and provide answers to the question of why certain educational content and ways of teaching should be privileged.

2.1 Scientific literacy and curriculum emphases

Despite the main goal of science education being to raise a scientifically literate society (Osborne 2023), the dissensus on what scientific literacy means and what is expected from a scientifically literate citizen can lead science teachers to have different interpretations of science teaching. These differences may have considerable repercussions in science education, such as being unsure about what content to teach, which can even lead to exclusion of specific scientific content in classroom practices (Smith et al., 2012). This can be, for instance, avoiding teaching certain subject or topics (Skolinspektionen, 2011).

2.1.1 Visions of scientific literacy

In order to provide a framework for studies of the selection of educational content in science education, Douglas A. Roberts (2007) identified two approaches to scientific literacy: Vision I, and Vision II. Vision I focuses on scientific knowledge for its own sake and emphasizes scientific concepts, facts, theories, and processes. It also includes recognizing the viewpoints of scientists within their respective domains. In this frame, it can be said that science education should aim to cultivate future scientists and recruit academic quests within the field. To illustrate, within Vision I, a scientifically literate person should possess a foundational scientific vocabulary, skills for conducting laboratory experiments, and a positive attitude toward science. Vision II, on the other hand, covers not only scientific facts and concepts, but also human affairs in science, along with everyday coping, critical thinking, and reasoning. In Vision II, science is viewed as a means to address practical, moral, and/or political problems, extending beyond scientific knowledge and facts. This vision also integrates science with other domains, such as the environment, technology, and society. By considering that science education is embedded not only in daily life but also in the culture, values, and norms about democratic actions, Vision II can also be defined even further. In their study, Lundqvist et al. (2013) classified Vision II into two categories: Vision IIa and Vision IIb. Vision IIa concentrates on the practical application of scientific knowledge in daily life, while Vision IIb addresses societal application of that knowledge, such as participation and engagement. In the frame of Vision IIb, the aim of science education is to equip students with scientific knowledge and skills that empower them to act, make informed decisions, and actively participate in scientific encounters such as socioscientific discussions. Some researchers proposed a third vision; Vision III (a term used for the first time by Aikenhead, 2007 and expanded later by other researchers such as Liu (2013)). As the line between Vision IIb and Vision III is not always clear (Sjöström, 2024), for practical reasons, this study expands the notion of Vision IIb in terms of socioscientific issues, scientific engagement, and action.

2.1.2. Seven curriculum emphases

Students often ask, "Why am I learning this?"— a question that reflects their need to understand the relevance and purpose of science education. This question is closely connected to students' conceptualization of scientific literacy, as it signals their search for meaning in what they are taught and how it relates to their lives and society (Olander, 2013). As a response to this question, Douglas Roberts (1982) formulated seven curriculum emphases; in which four of them, Correct Explanation (CE), Scientific Skills Development (SSD), Solid Foundation (SF), and Structure of Science (SS) emphasizes science for itself, in other words, Vision I and the three of them, Everyday Coping (EC), Self as Explainer (SE), Science Technology and Decisions (STD), are linked to science for allRoberts found these emphases in curricula and textbooks, but a few examples of analyses of curriculum emphases in studies of teaching practices can also be observed in the literature (e.g., Hamza & Lundqvist, 2023). This study draws on the curriculum emphases as a way to reframe the question from the perspective of the teacher: "Why am I going to teach this?" This serves as a guiding lens in our analysis of how pre-service science teachers conceptualize scientific literacy and their future teaching (Table 1).

Table 1. Seven Curriculum Emphases (Roberts, 1982; Olander,2013)

Emphasis	**"Why to teach science?"**
Correct Explanation (CE)	Scientific facts and processes privileged for their own right
Scientific Skill Development (SSD)	Learning scientific processes and acquiring process skills to achieve successful and new scientific outcomes
Structure of Science (SS)	Understanding how science works, including, relationship between theory and evidence
Solid Foundation (SF)	Scientific knowledge needed for further learning of science (e.g., a prerequisite for the next topic)
Everyday Coping (EC)	Scientific knowledge and explanations being important to deal with everyday issues
Science, Technology, and Decisions (STD)	Scientific explanations for democratic decision-making, values, and society, such as taking part in socioscientific discussions
Self as Explainer (SE)	Science being interesting, satisfying, etc. Metacognition

2.2 Comparative didactics approach to scientific literacy in teacher education

Comparative studies provide an empirical foundation for examining differences and similarities in science education across different countries. Teaching traditions and the history of science education differ among various countries and are guided by different national needs and social contexts. For instance, in their comparative study between Switzerland, Sweden, and France, Marty et al. (2018) observed decisive differences in the physics curricula in lower secondary schools. Academic tradition in science teaching focusing on scientific products or processes was represented more in Switzerland and France, whereas moral tradition focusing on moral, social, economic, or political issues in science was observed to a greater extent in the Swedish curriculum. Another comparative study between Turkish, Israeli, Swedish, and Czech science education systems, in terms of inquiry-based science education, was made by Heinz et al. (2017). The study showed that the implementation practices varied widely among these countries due to country-specific elements, such as dominant teaching patterns, the availability of supportive infrastructure, and alignment with educational goals.

Scientific literacy is a topic that teachers find challenging to implement within their teaching practices (Smith et al., 2012). Contextual differences may make it challenging for teachers in different ways, and these are likely to be reflected in their perspectives on teaching practices. In the literature, extensive comparisons of the levels of students and teachers from different countries can be found (e.g., PISA, TIMSS). These comparative assessments also guide the political debates on science education (Rundgren, 2018). Therefore, comparative studies on perspectives to reflect on the purposes and approaches of science education by considering a specific context are particularly valuable in providing deeper insights.

Contextual differences can significantly shape teachers' perspectives and motivations for teaching a specific science topic (Hessels et al., 2009). However, very little is known in terms of comparing scientific literacy from pre-service teachers' perspectives during teacher education, which is potentially a strong indicator of what and how they are planning to teach in the future. Comparing these perspectives from different contexts, alongside their articulation of future teaching practices, would be useful for revealing what is privileged in different countries, as well as providing an opportunity to learn from each other.

Moreover, Almqvist et al. (2023) stated that comparison in teacher education may be useful for designing didactics in both general and specific terms, and it allows for communicating knowledge about teaching. Comparison in a complex topic like scientific literacy might offer nuances on how science teacher education connects and prepares pre-service teachers for upcoming teaching or how it promotes the goal of raising a scientifically literate public. Although this study does not focus directly on the teaching and learning in classrooms or solely on didactical practices, an extensive overview of what is being offered to pre-service teachers before they start teaching in the classrooms is aimed by comparing pre-service teachers' perspectives on scientific literacy as the main goal of science education, especially in terms of content selection and teaching goals. This would reveal possible future teaching practices and address issues in science teacher education that might otherwise be taken for granted. Therefore, the above-mentioned question of "Why am I going to teach this?" may be replied to differently by participants from different educational, cultural, political, and social environments.

3 Aim, significance, and research questions

The purposes of science education have been an ongoing discussion for decades (DeBoer, 2000; Dubridge, 1946). Different approaches to purposes of science teaching opens up discussions on what implementations are present in teaching science (Lidar et al., 2018) and also in science teacher education. Visions of scientific literacy and curriculum emphases are well-known in research for describing the purposes of teaching science in curriculum documents (e.g., Knekta et al., 2022; Norambuena-Melendez et al., 2023) and teaching practices (Hamza & Lundqvist, 2023). Although Visions are used in more recent studies to frame pre-service science teacher education practices such as Vision III as an approach to Anthropocene in science teacher education, (Yavuzkaya et al., 2025), there is a need for a better understanding of science teachers` perspectives on scientific literacy in relation to future teaching practices in different contexts.

Participants from Türkiye and Sweden were chosen because both countries scientific literacy is emphasized, yet they represent markedly different cultural, political, and economic contexts. These contrasts make the comparison analytically productive. For example, Sweden's highly decentralized school system stands in contrast to Türkiye's centralized and nationally regulated structure. This reflects different political orientations toward teacher- and institutional autonomy and the governance of science teacher education (Cinarbaş, 2018). Economically, Sweden's welfare-state model and free-market capitalism (Enander et al., 2017) diverge from Türkiye's long-standing economic challenges and declining GDP per capita since the 1990s (IMF, 2017). Such economic differences influence teacher education, shaping priorities, expectations, and resource allocations. Aspiring to advance economy and technology as a national goal might lead to strive for a society proficient in Science, Technology, Engineering, and Mathematics (STEM). Sustainable development in specifically STEM fields has been a fundamental educational strategy for Türkiye, in which science teacher education goals are also shaped accordingly (Türk et al., 2018). Similarly, Sweden has also prioritized promoting STEM education to prepare students for careers in these field and to drive innovation and thus, economic growth (Rundgren et al., 2019). Although both countries prioritize similar economical goal, the differences in their economical status might result in prioritization of different aim of teaching science such as producing more scientists and addressing economical inequalities (Edlund, 2006; Åkerlund, 2020).

These contextual distinctions do not make the two cases incomparable; rather, they illuminate how similar policy aspirations can manifest differently, especially in a complex topic as scientific literacy. As mentioned earlier, both countries identify STEM advancement and sustainable development as national priorities (Türk et al., 2018; Rundgren et al., 2019), and in both contexts, science teacher education programs articulate ambitions to prepare teachers to teach current issues in science. Likewise, despite structural and political differences, the curricular documents from Türkiye and Sweden share several common content areas, such as explicit attention to sustainable development and a strong emphasis on laboratory skills (YÖK program description; University S1, S2, S3 program description and general science course curricula).

Thus, the two contexts are comparable because they pursue similar educational goals while operating within different systemic conditions. These differences make visible how scientific literacy is framed, interpreted, and operationalized in different teacher education traditions, and they offer a challenging basis for comparative insight.Moreover, scientific literacy is challenging to apply in teaching, and teachers' perspectives vary across contexts, making comparisons essential. By examining pre-service teachers' perspectives from different countries, this study investigates what participants in each context privileges and how future teaching practices may be followed. Such comparisons are significant for understanding taken for granted practices and contribute to improvement of teacher education programs and potentially address the well-known theory practice gap (Rasmussen & Rash- Christenssen, 2015).

By considering these conditions, the present study aims to explore Turkish and Swedish pre-service science teachers' perspectives on scientific literacy and thereby contribute to the field of science teacher education by revealing similarities and differences in their ways of describing and referring to teaching content, methods, and their experiences of science teacher education.

The study is guided by the following research questions:

1. What are the similarities and differences in perspectives of pre-service science teachers from Türkiye and Sweden on scientific literacy?
2. How do pre-service science teachers` perspectives relate to the science teacher education programs that the informants attend?

4 Method

4.1 Overview of Elementary Science Teacher Education in Sweden and Türkiye

Pre-service science teachers of grades 4-6 from three different universities in Sweden and pre-service science teachers of grades 5-8 from four different universities in Türkiye were recruited for the study. The selection of the three universities in Sweden was based on their similarity in terms of teacher education programs for science teachers, including duration, credit requirements, workload, and content. To exemplify, an overview of University S2 is given, in which pre-service science teachers undergo a total of eight semesters of study, and take courses in various subjects such as mathematics, Swedish, leadership, lesson plan theory and didactics, special education, English, learning and development, natural science theory and research methods, assessment and grading, and practicum. In the seventh semester, pre-service teachers can choose between a general science course or a social science course, both carrying 30 credits, equivalent to a workload of one full semester in Sweden. Those who choose to be science teachers follow the general science course and learn subjects such as biology, physics, geosciences, chemistry, and technology, as well as didactics of those subjects. The general science course covers several key topics, including sustainable development, species knowledge, photosynthesis, combustion and other reactions, ecology, human physiology, evolution, thermodynamics, meteorology, electrical engineering, and more. The course objectives in relation to scientific literacy includes; applying scientific knowledge to everyday phenomena, carry out laboratory work and discuss observations and results in a scientific manner, to communicate and reflect on scientific issues related to identity, sexuality and coexistence, to take a stand on issues where knowledge of subject is important for sustainable development, and to organize teaching related to values, emotions, aesthetics and ethical issues.

In Türkiye, science teachers in elementary schools teach only science, unlike Swedish teachers who teach other subjects. The science teacher education program consists of four years. In Sweden, there might be different departments involved in the general science course, whereas in Türkiye, a similar education is given in separate courses, instead of one large course, again from different departments. In Türkiye, subject courses such as physics or biology are given either by the corresponding department of the university or the education department as separate courses. Students also need to take educational courses in addition to science teaching-related courses, which would be considered similar to the didactics part of the general science course in Sweden. Some examples of subject knowledge courses are organic chemistry, calculus, geology, and astronomy. Examples of educational courses would be educational psychology, history and nature of science, methods of science teaching in elementary school, and laboratory applications in science teaching. In Türkiye, all universities follow the formalities from the Higher Education Council (YÖK, n.d.), making teacher education more centralized than in Sweden. The duties of YÖK include controlling the administrative and academic structure of universities, determining education and research policies. Therefore, universities are able to arrange their own teaching programs but need to follow the guidelines from YÖK, which assures basic standards. To give an overview on what objectives and definitions are involved in relation to scientific literacy in Türkiye, one of the science teaching course objectives include to be aware of the characteristics of a scientifically literate individual, who can distinguish science from pseudoscience. This followed by the objectives including analyzing the accuracy, validity, and reliability of information, transfer the causes and solutions of environmental problems to daily life, to be aware of elimination of misconceptions commonly seen in the field of science. Also, to plan, conduct and report various experiments based on different laboratory approaches, and to place the importance of scientific process skills in experiments were also included in the same course as objectives.

4.2 Participants and Data Collection

The present study recruited a total of 17 pre-service elementary science teachers. The Swedish data were generated when the participants had just completed the general science course. As the Turkish science teacher education program is spread over four years, the participants among third- and fourth-year students and a new graduate were chosen.

The reason why pre-service science teachers from the third or fourth year in Türkiye were selected and at the end of the general course in Sweden was that in both countries was that the participants had almost totally completed their subject and science teaching courses and been preparing for practicums, which would be their first science teaching in classrooms with pupils. In the Swedish context, the general science course is the last occasion where they learn science subjects and didactics before the practicum. In Türkiye, it is very similar; in the third year, the students are more likely to complete subject courses and fundamental education courses before the practicum. In other words, in both countries, the participants were chosen from among those who were assumed to be ready to plan their classroom teaching and with enough competence both in science subjects and didactics. The overview of participant demographics is summarized in Table 2 below. For anonymity concerns, pseudonyms are used for the participants, and the names of the universities, cities, and any other demographic information not directly related to the study (ethnicity, age, etc.) are not given.

Table 2. Overview of the participants

	Partici-pant	**University**	**Motivation to become a science teacher**
Sweden	Svante	University S1	“I enjoyed teaching before, and among other subjects, science is the most interesting.”
	Matilda	University S1	“I like kids, and I have an interest in nature and the outdoors”
	Olle	University S1	“it's closer to what I want to do; mathematics is my thing”
	Hanna	University S2	“I'd just like to be around children and mix learning and teaching parts since I was a little girl.”
	Charlotte	University S2	“I like kids, so I want to teach them.“
	Lena	University S3	“There is a great loss of science teachers in Sweden. That means that in the future, when I become a teacher, I will have a big fat paycheck.“
	Christian	University S3	“Social science is a little bit too difficult. I don't want to be too political in teaching; natural science is more objective.”
Türkiye	Defne	University T1	“My teachers at high school recommended that I become a teacher. I thought I could, but it was not my first choice.”
	Rüzgar	University T1	“I was raised in a big family, which made me like kids and crowds. I have always been told that I am good at explaining.”
	Deniz	University T1	“I wanted to be a mathematics teacher, but my score was not enough, so I chose science.”
	Cansel	University T2	“I did not even know there was such a department called science education. I never thought of being a teacher. One day, my dad recommended that I could become a science teacher. I thought it was a good idea.”

	Gizem	University T2	"Let's say because I had to. Because I wanted to be a nurse and I took the university entrance exam for three years, but I couldn't get the score I wanted. Among my preferences addition to nursery and midwifery, I could get into a science education program."
	Güneş	University T2	"I wanted to be a teacher anyway because I love kids. The reason I chose science is that I love experiments. Science teaching turned out to be the most compatible of the two."
	Burcu	University T3	"I really wanted to be a teacher anyway, and one of the best choices seemed to be science because I had no interest in mathematics."
	Bilge	University T4	"I actually did not want to be a teacher. Somehow, it came to my mind as a good option."
	Devrim	University T4	"My science teacher's first assignment was in our class. I thought of him/her as similar to me. It was like I had seen the future. At that moment, I wanted to be in his/her place."
	Beren	University T4	"I always wanted to be a teacher, and my score was enough for the science subject."

4.3 Procedure and Data Analysis

The study employs a qualitative approach. Data were generated through interviews designed to be semi-structured to ensure both flexibility and room for participant reflection (Horton et al., 2004). The interviews, conducted in English for the Swedish participants and Turkish for those in Türkiye, had 15 predetermined open-ended questions. The interview guide included questions about different categories, such as perceptions of the definition of scientific literacy, scientific literacy in their teacher education, curriculum, and content perceptions, and future teaching for scientific literacy implications. These were designed in the manner of the "why am I going to teach this?" question, as described earlier.

The same interview guide was followed in both countries. It was prepared in English originally and piloted with two participants in Sweden. Following the pilot study, only minor revisions were made, primarily the addition of follow-up questions. For example, the question "What is your ideal science curriculum?" was expanded to "What is your ideal science curriculum—in terms of objectives, content, and goals?" After finalizing the English version,the interview guide was then translated into Turkish for the participants in Türkiye. For validity concerns, the translation-back translation procedure with an external researcher in science education whose mother tongue is Turkish and who is proficient in English was followed.

In addition to these validity procedures for the interview, expert interviews were also conducted in both Sweden and Türkiye. Four experts in science education were consulted, and a think-aloud protocol (TAP) was used with each expert (Gill & Nonnecke, 2012) to identify potential ambiguities or weaknesses in the interview guide. Only minor linguistic refinements such as using “future teacher” instead of “teacher candidate” were necessary following this process.

Furthermore, the codes were reviewed by a research group consisting of experts in science education and other areas of didactics. A coding workshop was also held with two senior science education researchers from this group who had not participated in the earlier stages. They independently coded selected transcript excerpts, including segments the author was confident and relatively less certain about. Their coding was then compared with the author’s. No codes required revision, indicating a high degree of consistency and supporting the reliability of the coding process.

The interviews had to be conducted in different languages because the author, whose first language is Turkish, generated the data. This situation brought different positionalities to the researcher in different contexts. In Sweden, the participants demonstrated a great readiness to elaborate on their perspectives to the researcher, who has a different background. This created an environment in which participants were eager to explain the contexts and experiences more in detailed for a “foreigner”. The participants were also given the option to switch to Swedish during the interview if they felt uneasy with English. Nevertheless, all participants were proficient in English and did not need to switch languages at any point. On the other hand, in the Turkish context, the researcher was seen more as an insider by the participants. This helped the researcher to navigate directly into the interview questions and it can be told that it facilitated the interview to be more of a two-way interaction. While this might appear as a limitation, different positionalities during data generation facilitated the acquisition of more nuanced and fruitful replies from the participants, as well as allowing the researcher to better navigate the interview.

In the two countries different sampling methods needed to be followed to be able to reach as many participants as possible and made the data more comparable as more people could be reached. In Sweden, the participants were contacted through various means, such as email, personal contacts, or the universities’ own learning management system, over seven semesters. They received a brief message explaining the purpose of the study, its format, and the measures taken to ensure anonymity. Additionally, teacher educators in charge of the general science course were also contacted, asking them to inform the pre-service teachers about the project. Furthermore, the author attended some of their regular science course lectures as an observer and presented an overview of the project to address any inquiries they may have had.

In Türkiye, the snowball sampling method (Noy, 2008) was followed. Participants were contacted via personal contacts during the fall semester of 2022. Among the volunteers, those who fit the study inclusion criteria were contacted through email or phone calls to explain the details.

To analyze the data, a qualitative content analysis approach (Bryman, 2016) was employed, specifically utilizing reflexive thematic analysis (Braun & Clarke, 2023), and the software MAXQDA 2022 was used for practical purposes. The reason for using content analysis was that it allowed for more descriptive data, expressing what perspectives were there, while reflexive thematic analysis allowed more flexibility and acknowledged the researchers' different positionalities, and possible biases as stated earlier in both contexts (Braun& Clarke, 2023). The approach to the data can be characterized as abductive, incorporating preliminary codes such as visions and curriculum emphasis as defined in the analytical framework (Table 3), in addition to the emergence of any other code during the analysis.

Table 3. Analytical Framework of Visions and Curriculum Emphases (CuE) (Roberts 2007, Lundqvist et al., 2013)

Vision	**Vis I**	**Vis II**	
CuE		**Vis IIa**	**Vis IIb**
	Correct Explanation (CE)	Correct Explanation (CE)	Correct Explanation (CE)
	Scientific Skills Development (SSD)	Scientific Skills Development (SSD)	Scientific Skills Development (SSD)
	Solid Foundation (SF)	Solid Foundation (SF)	Solid Foundation (SF)
	Structure of Science (SS)	Structure of Science (SS)	Structure of Science (SS)
		Everyday Coping (EC)	**Science, Technology, and Decision (STD)**
		Self as Explainer (SE)	

The emphases added are shown in bold to underline that the previous CuEs (Vis I emphases) are still included but not the only focus.

The analysis is two-fold: (1) content analysis of curriculum emphases in both countries; (2) thematic analysis of differences and similarities in the two countries. Firstly, the curriculum emphases in the two countries were analyzed descriptively. In other words, the transcribed data in both countries were coded in terms of seven emphases (Appendix A). This was done by defining patterns of privileged emphases to the answers of the questions related to what they think it is important to teach for each participant and the patterns within the specific country. In addition to the codes of the seven emphases, room for a possible different emphasis was considered in case the privileged articulations would not fit into the framework. The second step follows thematic analysis, where how these differences/similarities in curriculum emphases appear in context was analyzed. In addition to the descriptive results, the emphases were delineated in terms of differences and similarities with corresponding themes. In the second fold, the data were read again with more specific lenses, looking at how similarities and/or differences in the perspectives were present in relation to teacher education, together with inclusion and exclusion of scientific content. While doing this, no cause-effect relationship was considered, but only descriptions of how the patterns were related to teacher education. After initial codes were generated, similar codes were combined under the themes. In addition, what content being included/excluded in pre-service teachers' perspectives was deliberately focused when describing scientific literacy in two countries. The aim of doing so is to gain a more comprehensive view of what might be taken for granted in pre-service science teachers' perspectives of future teaching for scientific literacy.

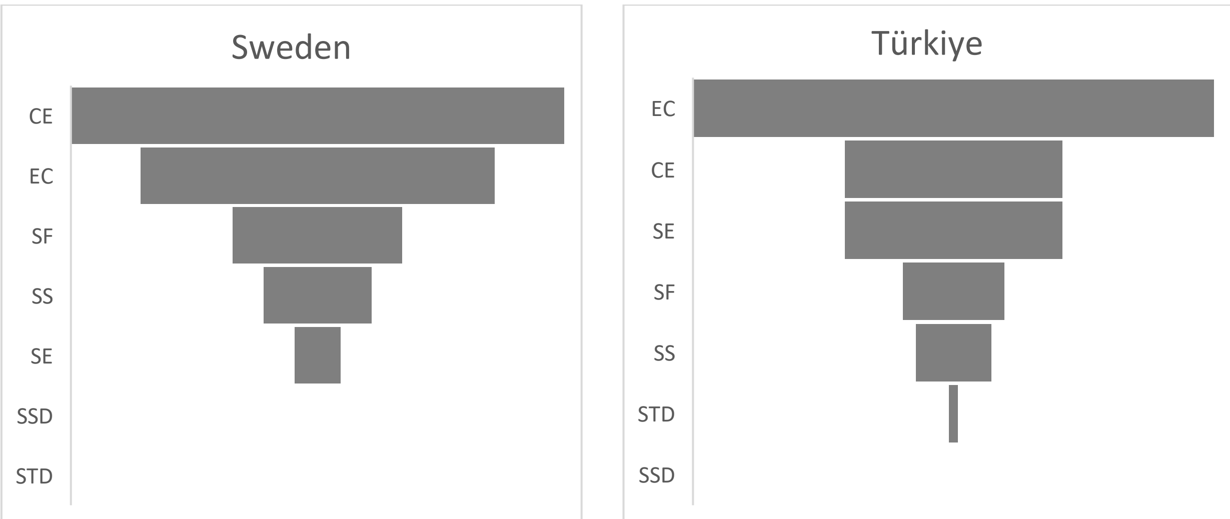
5 Findings

5.1 Descriptive analysis of curriculum emphases

In the descriptive analysis of curriculum emphases of pre-service science teachers from Türkiye and Sweden, different tendencies with some similarities when they were talking about “why am I going to teach this?” were observed. Figure 1 gives an overview of relative importance given to the emphases in each context and do not include any quantitative measurement. Participants from both countries demonstrated a strong emphasis on Correct Explanation (CE) and Everyday Coping (EC), with no emphasis on Scientific Skills Development (SSD), and almost none on Science, Technology, and Decisions (STD). Only one participant, Cansel, among 17 mentioned Covid and vaccination in terms of making an informed decision, which is an example of content coded as STD. Except for this example, no single emphasis on STD was observed from either country. In more detail, a majority of the participants from Türkiye strongly expressed their perspectives on scientific literacy as the use of scientific knowledge in daily life encounters (EC). They explained that everyone needs to have a level of scientific knowledge that enables them to understand basic things in their daily life. For example, Defne stated that science is important to explain daily life encounters with an example

> “Let’s say they [students] are in a car, they need to know about friction force to explain why a car stops when the driver brakes”

Figure 1. The importance of Curriculum Emphases (CuE) in Pre-service Teachers` Talks



The most important topics to teach, according to Turkish participants, were astronomy, systems in the human body, and acids & bases. The topic of evolution also appeared as important to teach in Türkiye; however, most of the participants mentioned it with a critical tone on the exclusion of evolution from the national curriculum and expressed that it should be included again. In Sweden, a couple of participants stated that scientific knowledge would be useful to students for knowing their own lives, such as Hanna's example of;

> "[what is important to teach in science], I think, maybe the biology part. That's the best because you can't do whatever you want with the body because the body will react."

In addition to the human body, the other topics important to teach according to Swedish participants were evolution, animals, and nutrition.

Even though Correct Explanation (CE) often appeared in both countries, the participants mentioned it in different ways; as a necessity of the national curriculum and exam in Türkiye, rather than what they think it should be, and as rich content in Sweden without formalities. For instance, when Bilge was talking about the aim of teaching science, she stated:

> "If we think about Türkiye, for parents and students, it [scientific knowledge] is generally for preparing for the exam. They use it to get into a good university. But we can think of it as general science education, in order to raise scientifically literate people who can make sense of the events in nature."

In Bilge's talk, scientific facts and concepts were important to teach because of the upcoming national exam with more advanced questions, and it is what students and parents care about, which would imply SF emphasis. Nevertheless, her personal stance regarding the aim of teaching science was to raise scientifically literate people in relation to being able to use this knowledge to make sense of nature, which shifts her own focus to CE.

Participants from Sweden expressed greater importance to CE, with no specification of formal requirements. Their perspectives on teaching content had more to do with their personal understanding of science rather than referring to the formal national curriculum or exam requirements. For instance, Matilda articulated it more succinctly during her reflection on how rich science is in content and knowledge:

> "Science is something that we can look into and we can find answers from[...] it will tell what is true, what is not"

Here, as opposed to Bilge, Matilda's opinion was that science is used to find (correct) answers, with no specification of exam or any external source. Although it is a short description, she stated her understanding of science strongly as something that gives certain answers when needed.

As can also be observed from Bilge's talk above, participants from Türkiye used the concept of "scientific literacy" (SL) explicitly, while this was not observed in the talk by Swedish participants. However, regardless of the explicit use of the concept of SL, the definitions varied among the participants. To illustrate, unlike Bilge`s explanation of SL as more of a "tool" to understand nature, Rüzgar explained it as follows:

> "Scientific literacy is to be able to follow the developments in the field of science, have knowledge, and make inferences about them."

Furthermore, a difference between the two countries in terms of Self as Explainer (SE) emphasis was noted. SE was a clearly privileged curriculum emphasis for the participants from Türkiye, whereas it was given very little to those from Sweden. SE occurred more often in the Turkish context, mostly in relation to metacognition, lifelong learning, and self-regulation in learning and teaching science. These aspects were articulated in regard to the necessity of being a 21st-century citizen. They stated that a scientifically literate person should aim to reach higher levels of scientific knowledge and abilities in life, even outside of school, with the help of knowing how to learn science. This also came along with teaching them to reflect on their own science learning. For instance, Burcu explained that every citizen should be able to have critical thinking skills, and she followed by saying:

> "...These [critical thinking and learning how to learn] are also 21st-century skills. Science education should teach them [pupils] how to learn. Science is the most appropriate subject for this."

Likewise, Devrim addressed similar skills necessary for science education and reflected that she wanted to use reflective science diaries in her teaching, as she did in her astronomy course at the university, as a part of her teacher education.

Unlike the above cases, participants from Sweden did not emphasize any metacognition, lifelong learning, or self-direction/regulation in science education. SE appeared differently: "science is exciting". For instance, Svante stated how interested he is in science in his free time:

> "Among the other subjects, science is the most interesting to me [...]I'm personally trying to learn stuff about science now, I look at quantum physics and that's not for my future students."

Structure of Science (SS) emphases appeared in different ways in the talks of participants from the two countries. Participants from Türkiye mostly focused on the nature of science with regard to evidence from daily life and/or referring to theories, as well as on the fact that scientists work collaboratively, which can be fostered in science classes, whereas the participants from Sweden mostly focused on distinguishing science from pseudoscience, such as understanding whether something in the news was scientifically investigated or not.

In the case of STD, among all 17 participants, only Cansel mentioned that science can help people to make decisions about social issues, such as deciding if one should be vaccinated against coronavirus, as it was a pandemic, and personal decisions would affect other people. No other participant emphasized STD. Some participants were even specifically asked about science education in relation to topics like global citizenship and sustainable development; they either stated that they did not know, they do not think it is appropriate to teach these topics at the elementary level, or they shifted the emphasis to Correct Explanation (CE), Everyday Coping (EC), and/or Structure of Science (SS). Hence, values, scientific engagement, or democracy were excluded from teaching content in their talks about science education.

5.2 Thematic Analysis of Curriculum Emphases across the Countries

In this step, the focus is on how the differences and similarities between the countries in the first step appear. As a part of the reflexive thematic analysis process, the following two themes were formulated: Teaching for Scientific Literacy and Problematizing Science (Education).

5.2.1 Teaching for Scientific Literacy

Starting from the motivation to teach science, specific ways of articulation of teaching science as a profession were found. For instance, the reasons why participants from Sweden wanted to be a science teacher were because of interest in scientific content or the ease of finding a job since there is a shortage of science teachers in Sweden, while some of those from Türkiye did not want to be science teachers but it was the subject most available to them based on national exam scores, and teaching science was seen as "why not?". In both countries, there were participants who expressed that they wanted to become teachers, but we observed no traces of scientific engagement-related reasoning or motivation to teach science (Table 2). Wanting to teach science for scientific engagement reasons, such as "I want to teach science because everyone should be able to decide if they will vote for those who deny climate change," would have indicated a certain vision (Vision IIb) of scientific literacy.

When the participants were defining scientific skills and abilities in relation to what a scientifically literate citizen should have and therefore important to teach, in the Swedish context, there was a strong tendency to refer to scientific content knowledge, although the question was specifically about the scientific skills and abilities. For example, Olle was asked what scientific skills and/or abilities he thinks a citizen should have, and he answered:

> "I think it's much about understanding science. It is something based on fact. It's something that is tested and retested, to try the right things several times, so it's more accurate. It's not just beliefs. [...] So, we can rethink what seems correct or not correct."

On the contrary, participants from Türkiye defined, more specifically, science process skills and engineering skills as necessities of being scientifically literate citizens. Devrim described those skills as even more detailed and advanced, such as being able to make predictions depending on scientific knowledge. To illustrate, she stated:

> “It could be science process skills or engineering skills. First of all, everyone should definitely know how to make a scientific observation. It can also be recording data and researching. […] Everybody should have [the skills for] cooperation and formulating a hypothesis based on it.”

Like Devrim, the most articulated scientific skill that every citizen should possess, according to the majority of the Turkish participants, was also being able to make scientific observations. In both countries, the participants expressed that being able to conduct a laboratory experiment was unnecessary for teaching scientific literacy at the elementary level.

However, regardless of the explicit use of the concept of “scientific literacy”, like Rüzgar’s example above, the definitions of it varied among them. For instance, Devrim articulated scientific literacy as a level to reach for students:

> “Of course, not everyone can know at the level of scientific literacy, but of course, they need to know a little. To give an example, everyone should know that they should not mix salt, spirit, and bleach for their health.”

In Devrim’s talk above, the level of scientific literacy was something more than knowing the danger of mixing salt spirit and bleach. In this example, Devrim emphasized EC as an indicator of a layperson rather than a scientifically literate person.

Furthermore, one of the focuses on teaching for scientific literacy was STEM-related activities, whereas this was never observed in those from Sweden. For instance, Devrim pictured her future science teaching as including activities based on everyday applications and STEM. Technology was specifically articulated by the participants from Türkiye as a tool to teach subject content.

Lastly, an important part of teaching for scientific literacy appeared as outdoor education in the Swedish context, whereas more classroom-based activities were dominant in the Turkish context. The participants from Türkiye strongly emphasized some teaching methods based mostly on constructivism. Regardless of the country, participants talked about their future teaching activities and the way that they learn during teacher education. This was in the form of “*I will apply X activity/teaching method in my classroom as I did in the Y course at the university*”.

5.2.2 Problematizing Science Teacher Education

As in the theme of concerns about science teacher education, participants were observed to problematize science and science education. A significant difference between countries in this regard is the political tone of the articulation. The participants from Türkiye have a critical approach to the current education system, whereas no such tone is observed in the Swedish context. All of the participants from Sweden stated that they thought the current national curriculum for science education for grades 4-6 was good enough, and they were satisfied with it. Unlike Sweden, those from Türkiye were more critical of the science curricula and science education. One of the most repeated topics was the exclusion of evolution from the Turkish curriculum. All Turkish participants stated that it should be included back in the curriculum since understanding how science works with regard to scientific methodology (based on observation and experimental evidence), the theory-laden nature of science, and the distinction of theory and law are important elements of science teaching. Evolution was also a topic that participants from Sweden brought up, but not as a means to criticize the curriculum, but to describe the difficulty of teaching the relationship of religion and science. For instance, Lena stated:

> "It is also important to know where we come from. Then [teacher educator's name] talked a lot about the religious side, where we come from, and what the meaning of life is. I think that's fine. If you have your religion, it is ok, but put it aside when you talk about science. As a science teacher, you must also be prepared to attack those questions because there will always be pupils asking about them."

On the other hand, Burcu brought up the relationship between religion and science from a political perspective:

> "Of course, evolution should be taught. It's a nerve-racking subject. It has to be taught. There's nothing to discuss about it. It is very much associated with religion and morality in our country. But it has to be taught. Again, in the same way, the menstrual cycle needs to be discussed very clearly. Reproduction, sex education, etc. These topics have also been greatly reduced, and are associated very much with religion and 'going astray'."

When talking about sensitive topics like evolution, religion, or immigration, Turkish participants were more hesitant to talk. Most of them needed to be reminded that they would be completely anonymous and that the interview was a safe place to talk about their own perspectives.

Besides the criticisms of the curriculum, participants from Türkiye stated various challenges in science education regarding Türkiye's socioeconomic, cultural, and geographical situation. For instance, Burcu stated:

> "For example, a teacher who will be assigned to [a disadvantaged city in Türkiye], where students cannot even show up in the class, let alone be taught to use an instrument in a laboratory. Or the student doesn't even know Turkish, or he can't listen to the lecture because he is hungry, so he faints."

She problematized science education not only regarding the curricula but also how teacher education was designed for ideal classrooms, in which the situation in Turkish classrooms was more likely to be different. This situation was also reflected in terms of Turkish science curricula being adapted from a Western science curriculum:

> “As far as I know, the science curriculum in Türkiye is the translation of the Canadian science curriculum. This is terrible. I mean, yes, it is very nice, but it is not realistic for me. The curriculum in Türkiye is based on a completely irrelevant program.”

In terms of the content of science teacher education, there was a critical tone in their reflections on “why am I going to teach this?” in both countries. The participants from Sweden stated that they did not learn enough subject knowledge in the general science course, and they wish to learn more. For instance, Svante expressed that he wanted to learn more scientific subjects rather than how to teach science:

> “I think the balance [didactics and subject knowledge] is too much towards the didactics. We had that science content earlier, but I think the balance is maybe 50- 50. I think there should be more science content and less didactics.”

Olle even stated that didactics, or the teaching part, could be the same as the other subjects, but scientific knowledge cannot be learnt anywhere else:

> “I could maybe take the didactics from other courses and implement them in the science subject. I would like to have the knowledge in science, not didactics. Of course, some didactics is nice, but it's not as important as the subject skill. “

This wish to learn more about subject didactics was also brought by Christian, including the lack of assessment of scientific knowledge:

> “I understand the levels to get into a teacher program are very low because nobody wants to do this job today. So far [in the general science course], there are no real checks to see what we know. You could become a science teacher with very very little knowledge.”

On the other hand, the ones from Türkiye stated the opposite, that they learn too much and too advanced content knowledge that they would probably not need to teach in the future. Their wish was to learn less subject knowledge because they would not become scientists but teachers. For instance, Deniz wishes to learn more about how to teach science rather than the subjects

> “Researcher: What do you think you need to know to be a science teacher?”
> Deniz: Basic level of science is enough.
> Researcher: What is the basic level?

> Deniz: Not what we learn. I think we are learning too much physics, chemistry, and biology for teaching those grades [5-8]. A program focusing on how to teach, what methods to use, etc., would be more helpful[...] we do not need to know physics like a physicist, chemistry like a chemist."

6 Discussion

As a response to the first research question (RQ1), the present study showed that pre-service science teachers from Türkiye define scientific literacy foremost in terms of the applicability of scientific knowledge to daily life in the frame of Vision IIa, whereas those from Sweden prioritize scientific knowledge with regard to what is recognized as "correct" in the scientific community, which refers to Vision I. Nevertheless, scientific knowledge was not recognized with regard to values, democracy, inclusion, making informed decisions, socioscientific issues, or engagement in society, history, or culture by the participants from either country, which would have been classified under Vision IIb. Regarding the second research question (RQ2), the study also found that teacher education is very central in pre-service teachers' perspectives, and they reflected their future teaching plans primarily in the way they were taught during their teacher education, together with the differences in different countries.

Starting from curriculum emphases, in both countries, the strong focus on Correct Explanations (CE) and Everyday Coping (EC) seems to be an important subject for the stakeholders in teacher education. In Sweden, although the Swedish science curriculum is aligned with the moral tradition (Marty, et al., 2018), i.e., Vision IIb, which aims for students to not only have the necessary scientific knowledge but also be able to apply this knowledge to the surrounding world as well as engage in socioscientific issues at local and global levels, including critical thinking skills, the present study showed that there are pre-service science teachers in Sweden who seem to give greater importance to teaching scientific facts instead.

Conversely, participants from Türkiye appear to have a strong tendency to teach scientific literacy in terms of EC, and their future science teaching is in the frame of Vision II (but only in a restricted way). Like those from Sweden, we still see no indication of their future teaching for scientific engagement or socioscientific issues. In both countries, what they learn during their teacher education seems to be a guiding factor in their future teaching for scientific literacy, as they expressed that they want to teach in a similar way as how they were taught during their teacher education courses. In the Swedish case, the curriculum for compulsory school is not clear for science teachers in terms of how exactly they would apply those aspects to their teaching (Marty et al., 2018). Teacher education can be a potentially open space for pre-service science teachers to learn to foster other emphases in science education, for instance, that students should participate in democratic decision-making practices (Science, Technology, and Decisions, STD).

When it comes to other Curriculum Emphases, Self as Explainer (SE) appeared fairly different in the two countries. The fact that pre-service teachers from Türkiye focus on metacognition and science education might have resulted from the constructivist science curriculum implementation that has existed in Türkiye since 2000 (M.E.B., 2000). Since teacher education is more centralized in Türkiye (Çakıroğlu & Çakıroğlu 2003), science teachers all over the country are supposed to be trained to teach this curriculum. Also, it can be understood from the reflections that pre-service teachers seem to emphasize metacognition and self-regulation in science education because they have been trained in this way, such as writing learning diaries in the astronomy course. Those activities might also guide their future teaching if they want to teach in the same way.

Although metacognition and self-direction in science education could lead to scientific engagement, even the Turkish participants who expressed the importance of metacognition in scientific literacy do not seem to have perspectives related to scientific engagement or action, but seem to be aware of what they learnt in terms of content. In the case that Science, Technology, and Decisions (STD) is a goal, acting upon socioscientific issues can be reinforced by students monitoring their own learning of science, critically evaluating, and planning their actions, such as participation in peer communities, as highlighted earlier (Hauge & Barwell, 2017).

Unlike the Turkish context, the participants from Sweden gave almost no importance to metacognition or lifelong learning but slightly emphasized how interesting science is. When considering the Bildung tradition in the Northern European countries, including Sweden, metacognition is important for scientific literacy (Avargil et al., 2018). Sjöström and Eilks (2018) discuss even further that science education should include metacognition in the frame of Vision III, complemented with transformation. However, it should be considered that transformation might be further distanced when there is not even an indication of metacognitive practices included in pre-service teachers' talk about planned future teaching for scientific literacy.

Scientific Skills Development (SSD) emphasis did not appear in any of the talks, which is also in line with the fact that participants from both countries think that laboratory skills are not the most necessary task to teach for scientific literacy. The participants mostly referred to other emphases when they talked about scientific activities or research, rather than valuing them because of further new knowledge. These articulations were found more in terms of Correct explanation (CE) and the nature of science, i.e., Structure of Science (SS). Moreover, although this study does not focus primarily on perspectives on the nature of science, the participants from Sweden emphasize CEand thereby perceive science as deterministic and objective. In other words, something that gives answers. This is in line with previous literature that suggests science is perceived as a factual entity by pre-service science teachers (Özden & Yenice, 2022). Even though the participants from Türkiye connected science with daily life more than their Swedish counterparts, there were, nevertheless, no references to recognizing the limits of science, either. However, scientific literacy requires that the limits and nature of science are recognized for value-driven scientific discussions, which are important for the abovementioned socioscientific issues, such as, for example, climate change (Block et al., 2019). Therefore, to foster scientific engagement in society, it is crucial to have science teachers who recognize how science works, the extent to which science can actually inform, and its embeddedness in values and culture.

Moreover, a difference between the countries in terms of the pre-service science teachers' criticism of science education was observed. In Türkiye, the pre-service science teachers problematized the science curriculum, whereas in Sweden, there was no such problematizing tone. The problems related to Türkiye's needs in terms of teacher education have been brought up earlier (Çakıroğlu & Çakıroğlu 2003), and the present study showed that there are future science teachers stating that this is still a problem. As Burcu stated, Türkiye still has differences in cultures and economies between rural and urban regions. Thus, educational needs also vary in the different regions. Since Turkish teacher education is designed to raise teachers according to the science curricula, which is centralized and the same throughout the country, no specialized teacher education for a specific region or culture is given. Although there is also a centralized science curriculum in Sweden, teachers have relatively more autonomy to decide on the content of the topics and how they are taught. The reason that future teachers in Sweden in this study might not have such a critical voice about the science curriculum as those in Türkiye might be related to this kind of autonomy in teaching, especially when it comes to what to teach. Moreover, the fact that Turkish teacher education programs originated from Western knowledge (mostly UK and USA-based) has been an issue in Turkish teacher education, as the curriculum does not correspond to the actual needs of the society (Çakıroğlu & Çakıroğlu 2003). Framing curriculum in developing countries by using a Western style, and having science curriculum far from the local needs and culture, has been stated to have consequences such as poor performance or low motivation (Mashoko, 2022); that this issue has also appeared in this study indicates that the problem is recognized by the pre-service science teachers. Moreover, the problems stated by future teachers in Türkiye regarding language, religion, and poverty might indicate that there would be more at stake related directly to the science teachers' professions compared to Sweden. For instance, in Türkiye, climate activism is mostly criminalized (Kurtiç, 2022), which might mean that fostering activism in science classrooms can have serious consequences for teachers. Although the criminalization of environmental activism is not only a problem of Türkiye (Butt et al.2019), and neither Sweden nor Türkiye has activism as a goal of science education, some actions that potentially lead to activism can be understood differently. These actions could be, for instance, opening up spaces for socioscientific discussions such as scientific questions and issues that require going beyond including only scientific facts and evaluating different approaches and alternatives to prioritize. In Sweden, teacher education is closely interconnected with themes of democracy and emancipation, highlighting the social constructs that underpin these discussions (Edling & Simmie, 2017). Science education rather has the potential to include students in gaining competence to handle these issues (i.e., action competence) (Breiting et al., 2009).

The topic of evolution appeared repeatedly, but in different ways. Comparing how this controversial topic appeared in the two countries in this study, it can be clearly observed that scientific literacy perspectives are intertwined with the country's cultural and political stance, and science teaching practices are affected by those. For instance, in Türkiye, the hesitation in criticizing the exclusion of evolution from the national curriculum might indicate that pre-service teachers will unlikely teach or even touch upon the topic. In Sweden, teaching evolution did not even appear as a matter of concern. However, Lena's perspective might indicate that pre-service science teachers in Sweden tend to teach evolution in a way of science being opposed to religion. This separation might also indicate that pre-service science teachers in Sweden perceive science education as a separate entity from the social and cultural environment, which might also guide their future teaching in the same way.

A tension between what is taught in the science courses and what the pre-service teachers experience was also found. To illustrate, elementary science teacher education in Türkiye includes more subject knowledge courses, such as physics and chemistry, but the pre-service teachers are oriented more toward EC rather than CE. On the other hand, in Sweden, the corresponding teacher education program has fewer science subject courses regarding science, but student teachers emphasized CE more. Although the study does not aim to address what is taught specifically in those courses, what pre-service teachers expect, and what experiences of teacher education are, might be a concern for stakeholders. Our findings confirmed the ongoing problem of disconnection between the teacher students' expectations of the content or format and what they were offered by the universities (Streller & Bolte, 2018), which takes the problem beyond these two countries.

As can be observed from the reflections related to curriculum emphases, teacher education is central to pre-service science teachers` perspectives on what scientific literacy is, and what their plans to teach are in relation to these perspectives. A clear formulation of "*I will apply X activity/teaching method in my classroom as I did in the Y course at the university*" is an indicator of how they are planning to teach in the future. Although from their talks, it is clear that they refer to their education at the university, however research shows that they might also be influenced from their own experiences of schooling. This could be, for instance, their motivation to become a teacher and teach in a similar way because of their favorite teacher or class in the school (Goodson, 2014).

The comparison of the two contexts suggests that some curriculum emphases especially within the STD emphasis may need to be reconsidered. Although pre-service teachers in this study explicitly stated that teaching socioscientific issues such as climate change was unnecessary, the absence or inconsistent interpretation of several STD-related topics in both contexts suggests that this emphasis may need to be rethought, particularly for the process of learning to teach. This reflects a broader challenge in both science teacher education and in science education: teachers' intended aims do not always align with their enacted classroom practices. For example, Almqvist et al. (2023) describe how Tanja, a teacher who aimed to prepare students for informed decision-making, ultimately focused on scientific facts rather than socioscientific issues in her instruction. The present study showed that comparative perspectives are particularly important because they illuminate nuances that might be taken for granted. For example, in Ates et al. (2025), which focused solely on Swedish science teacher education, Self as Explainer (SE) appeared marginal and was associated mainly with personal interest in science. However, in this comparative study, SE was articulated in relation to metacognition, lifelong learning, and learning how to learn in the Turkish context, revealing a dimension of scientific literacy that would have remained overlooked in a single-country analysis. Similarly, while Science, Technology, and Decisions (STD) was largely absent in both contexts, this absence becomes analytically even more significant in comparative contrast, showing a shared silence across systems rather than an isolated curricular gap. Thus, while Ates et al. (2025) identified which emphases were present among Swedish pre-service teachers, this study further reveals which aspects are contingent, contextually shaped, or missing altogether.

7 Limitations and implications

The current study has some limitations and implications for future research and practice. Firstly, since this study does not offer insights on actual classroom practices but only the pre-service science teachers` declarations, intentions, and future teaching plans, future research might delve into how these perspectives actually translate into teaching practices in the future with longitudinal data. Secondly, the present study did not look into the structure of teacher education programs, but teacher education emerged as a central guide in their perspectives. Thirdly, the study employed 17 participants in total, which can be considered as a small sample. By considering that Sweden is a relatively small country, an even smaller number of students had already been enrolled in the general science course, only seven students were eligible for this study among the positive responses. To keep the balance between the two countries, 10 participants from Türkiye were recruited. Nevertheless, the interviews lasted between 46 minutes to 2 hours 11 minutes, and the data was rich enough to have a fruitful insight to the participants` perceptions. However, the study can be replicated with a bigger sample size, which might result in change in the weights of different emphases, or potentially new emphases that was not covered by the analytical framework . Lastly, the present study did not delve into external factors leading to a certain perspective. Future research might investigate specific differences between different contexts to better understand what factors in teacher education cause these perspectives. These factors can be exemplified as teacher educators` instruction, content, and curriculum.

In addition to the theoretical implications, the study also offers practical implications for science teacher education. The absence of scientific engagement, or STD emphasis, in the pre-service science teachers` talk might be addressed by explicit approaches to teach complex topics like climate change. Teacher education is a good place for pre-service science teachers to practice both to discuss socioscientific issues and to learn how to foster discussions in their future teaching. These explicit practices might also be beneficial for pre-service science teachers to gain confidence to teach science, already early in their program. This might help them to be confident in teaching more complex topics later.

This might also indicate mixing and balancing practices from different traditions. Furthermore, strengthening focus on nature of science in teacher education might help future teachers to recognize how science works together with limits of science, tentativeness and uncertainty. This would help preparing teachers who can guide students in making informed decisions and discussions. Lastly, teacher educators might benefit from finding out more about their students` perspectives so that they could reorganize the respective courses according to the needs of future teachers.

Conclusion

The present study`s contribution to the field of science teacher education offers a comparative approach to pre-service science teachers' perspectives and application of scientific literacy in their future teaching. The study shows how pre-service science teachers from Sweden and Türkiye perceive scientific literacy and thus their aims of teaching science and how they are planning their teachings accordingly.

This study highlights the importance of understanding the varied perspectives of pre-service science teachers on scientific literacy in different educational contexts. It also shows differences in the emphasis placed on various aspects of scientific literacy using a comparative approach. Besides students' own experiences and beliefs, these differences might be influenced by national curricula, cultural values, and educational goals. The significance of this study lies in those unifying practices related to scientific literacy in science education might result in even a bigger gap between what pre-service science teachers' privilege and what they are offered. Although a need for global scientific literacy has been discussed by some scholars recently (Lederman et al., 2024), the contextual differences should not be taken for granted, especially in teacher education. The study thus shows that teacher education programs should not rely on curriculum documents alone; pre-service teachers` perceptions are important for intended future teaching practices. The insights gained from this comparative analysis indicate the need for tailored teacher education programs that consider these contextual factors.

Nevertheless, despite the clear contextual differences between the two countries a similar pattern emerged: pre-service teachers in both contexts paid almost no attention to Science, Technology, and Decisions (STD). This convergence, despite highly different conditions, might be concerning for science teacher education, as it suggests that preparing future teachers to address the societal and democratic dimensions of science remains an overlooked area across contexts.

Overall, the study shows that fostering scientific literacy is not only a matter of design of teacher education but also a matter of how future teachers conceptualize and privilege the purposes of science education. Understanding these perspectives is essential for designing teacher education programs that better prepare teachers to meet contemporary societal and scientific challenges.

Research ethics

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Institutional review board statement

Besides the guidelines of the Swedish Research Council (2017), an ethical vetting was conducted and approved by the Swedish Ethical Review authority (Etikprövningmyndigheten, Dnr 20220122001).

Informed consent statement

Informed consent was obtained from all research participants.

Data availability statement

The data generated for this research is not publicly available by the requirements of the vetting from the Swedish Ethical Review Authority (Etikprövningsmyndigheten, Dnr 20220122001). Access to the data can be granted only with the permission of the Swedish Ethical Review Authority upon request.

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Appendix

Curriculum Emphases- Analysis

CuE	**Identification in the participant`s articulation**	**More examples of response to "why am I going to teach this?"**
Correct Explanation (CE)	Statements privileged for their match with scientific facts, concepts and processes	"Science can explain how things are built. It is like how water is built from

		molecules. How they behave in certain tempartures and stuff.” *Charlotte*
Everyday Coping (EC)	Expressions of applying scientific knowledge into daily life issues.	“science is about life. Like, what happens when you cut yourself, what do you have to do?” *Hanna*
Solid Foundation (SF)	Statements appreciating a scientific knowledge to learn the upcoming topic, grade, etc.	“they need to have [basic] laboratory skills for the [next] biology course” *Gizem*
Structure of Science (SS)	Talks about how science works such as theory and evidence	“Science is something that it is tested and retested in and to try right things several times so it's more accurate. it's not just beliefs. it's like distinguishing what is science and what is not scientific.” *Olle*
Science, Technology, Decisions (STD)	Statements of making informed decisions based on scientific knowledge such as participation in socioscientific discussions	“Every citizen needs to know science to decide things in their lives […] like pandemic, they need to evaluate scientific knowledge to decide to get vaccinated” *Cansel*
Self as Explainer (SE)	Descriptions of how beautiful, interesting, nicely thought science is or metacognition and lifelong learning	“they need to know what to do with their knowledge. I make them keep learning diaries like we did in the astronomy

		course so that they can follow how they are learning and how to continue." *Devrim*
Scientific Skill Devel-opment (SSD)	Talks about scientific facts and processes that can lead to new scientific knowledge or product	No example can be found in the present study.

References

Aikenhead, G. S. (2007). Expanding the research agenda for scientific literacy. *Promoting scientific literacy: Science Education Research in Transaction*, p. 64.

Almqvist, J., Lidar, M., & Olin, A. (2023). Teaching Traditions in Classroom Practice–A Comparative Didactic Approach. In *Didactics in a Changing World: European Perspectives on Teaching, Learning and the Curriculum* (pp. 55-65). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-031-20810-2_4

Altun-Yalçın, S., Kılınç, A., & Akgün, A. (2011). Investigating scientific literacy levels of pre-service elementary school teachers. Procedia – *Social and Behavioral Sciences, 15,* 3096–3100. https://doi.org/10.1016/j.sbspro.2011.04.278

Ates, K.A., Lundqvist, E., & Almqvist, J. (2025). "Why Am I Going to Teach Science?": Pre-Service Science Teachers` Perspectives on Science Education. *Journal of Science Teacher Education*, *36*(6), 781–802. https://doi.org/10.1080/1046560X.2025.2452070

Avargil, S., Lavi, R., & Dori, Y. J. (2018). Students' metacognition and metacognitive strategies in science education. *Cognition, metacognition, and culture in STEM education: Learning, Teaching and Assessment*, 33–64. https://doi.org/10.1007/978-3-319-66659-4

Åkerlund, A. (2020). A competition state perspective on the development of Swedish policies for internationalization of higher education and research 1960s–2010s. *Nordic Journal of Educational History, 7*(2), 99–123. https://doi.org/10.36368/njedh.v7i2.203

Block, T., Van Poeck, K., & Östman, L. (2019). Tackling wicked problems in teaching and learning. Sustainability issues as knowledge, ethical and political challenges. In *Sustainable Development Teaching* (pp. 28-39). Routledge. https://doi.org/10.4324/9781351124348-3

Boz, Y., & Uzuntiryaki, E. (2006). Turkish prospective chemistry teachers' beliefs about chemistry teaching. *International Journal of Science Education*, *28*(14), 1647–1667. https://doi.org/10.1080/09500690500439132

Braun, V., & Clarke, V. (2023). *Thematic analysis*. In H. Cooper, M. N. Coutanche, L. M. McMullen, A. T. Panter, D. Rindskopf, & K. J. Sher (Eds.), APA handbook of research methods in psychology: Research designs: Quantitative, qualitative, europsychological, and biological (2nd ed., pp. 65-81). American Psychological Association. https://doi.org/10.1037/0000319-004

Butt, N., Lambrick, F., Menton, M. & Renwick, A. (2019). "The Supply Chain of Violence," *Nature Sustainability. 2*. 742–747. https://doi.org/10.1038/s41893-019-0349-4

Breiting, S., Hedegaard, K., Mogensen, F., Nielsen, K., & Schnack, K. (2009). *Action competence, conflicting interests and environmental education the MUVIN programme. Research Programme for Environmental and Health Education, DPU (Danish School of Education).*

Bryman, A. (2016). *Social research methods*. Oxford University Press.

Chin, C. (2005). First-year pre-service teachers in Taiwan: Do they enter the teacher program with satisfactory scientific literacy and attitudes toward science? *International Journal of Science Education*, *27*(13), 1549–1570. https://doi.org/10.1080/09585190500186401

Çakıroğlu, E., & Çakıroğlu, J. (2003). Reflections on teacher education in Turkey. *European Journal of Teacher Education*, *26*(2), 253–264. https://doi.org/10.1080/0261976032000088774

Cinarbaş, H. I. (2018). A Comparative report on Swedish and Turkish education system and teacher education. Retrieved on 26 May 2024 from https://www.researchgate.net/publication/325065848_A_Comparative_Report_on_Swedish_and_Turkish_Education_System

Dani, D. (2009). Scientific Literacy and Purposes for Teaching Science: A Case Study of Lebanese Private School Teachers. *International Journal of Environmental and Science Education*, *4*(3), 289–299.

DeBoer, G. (2000). Scientific Literacy: Another look at its historical and contemporary meanings and its relationship to science education reform. *Journal of Research in Science Teaching, 37*(6), 582–601. https://doi.org/10.1002/1098-2736(200008)37:6<582::AID-TEA5>3.0.CO;2-L

DuBridge, L. (1946). Science and national policy. *Bulletin of the Atomic Scientists, 1*(11), 12–14.

Edling, S., & Simmie, G. (2018). Democracy and emancipation in teacher education: A summative content analysis of teacher educators' democratic assignment expressed in policies for Teacher Education in Sweden and Ireland between 2000-2010. *Citizenship, Social and Economics Education*, *17*(1), 20–34. https://doi.org/10.1177/2047173417743760

Edlund, J. (2006). Trust in the capability of the welfare state and general welfare state support: Sweden 1997-2002. Acta Sociologica, 49(4), 395–417. https://doi.org/10.1177/0001699306071681

Enander, H., Larson, S. R., Sandvik, G., Norman, L. T., Helmfrid, S., & Weibull, J. (2017, December 15). Sweden. Retrieved on 26 May 2024, from https://www.britannica.com/place/Sweden

Gill, A. M., & Nonnecke, B. (2012, October). Think aloud: Effects and validity. Proceedings of the 30th ACM international conference on Design of communication (pp. 31–36). https://doi.org/10.1145/2379057.2379065

Goodson, I. F. (2014). Investigating the life and work of teachers. *Eesti Haridusteaduste Ajakiri. Estonian Journal of Education*, *2*(2), 28–47. https://doi.org/10.12697/eha.2014.2.2.02b

Hamza, K., & Lundqvist, E. (2023). Mangling didactic models for use in didactic analysis of classroom interaction. In *Didactics in a changing world: European perspectives on teaching, learning and the curriculum* (pp. 103-121). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-031-20810-2_7

Hauge, K. H., & Barwell, R. (2017). Post-normal science and mathematics education in uncertain times: Educating future citizens for extended peer communities. *Futures*, *91*, 25–34. https://doi.org/10.1016/j.futures.2016.11.013

Heinz, J., Enghag, M., Stuchlikova, I., Cakmakci, G., Peleg, R., & Baram-Tsabari, A. (2017). Impact of initiatives to implement science inquiry: A comparative study of the Turkish, Israeli, Swedish and Czech science education systems. *Cultural Studies of Science Education*, *12*, 677-708. https://doi.org/10.1007/s11422-015-9704-6

Hessels, L., Lente, H., & Smits, R. (2009). In search of relevance: the changing contract between science and society. Science and Public Policy, 36(5), 387–401. https://doi.org/10.3152/030234209x442034

Horton, J., Macve, R., & Struyven, G. (2004). Qualitative research: Experiences in using semi-structured interviews. In *The real life guide to accounting research* (pp. 339-357). Elsevier. https://doi.org/10.1016/B978-008043972-3/50022-0

International Monetary Fund. (2017). Turkey and the IMF. Retrieved 26 May 2024 from http://www.imf.org/en/Countries/TUR#whatsnew

Lederman, J., Akerson, V., Bartels, S., & Schwartz, R. (2024). Attention science educators, we have a problem: lack of global functional scientific literacy. *International Journal of Science Education*, 1–5. https://doi.org/10.1080/09500693.2024.2361934

Lidar, M., Karlberg, M., Almqvist, J., Östman, L., & Lundqvist, E. (2018). Teaching traditions in science teachers' practices and the introduction of national testing. *Scandinavian Journal of Educational Research, 62*(5), 754–768. https://doi.org/10.1080/00313831.2017.1306802

Liu, X. (2013). Expanding notions of scientific literacy: A reconceptualization of aims of science education in the knowledge society. *Science Education for Diversity: Theory and Practice*, 23–39. https://doi.org/10.1007/978-94-007-4563-6_2

Lundqvist, E., Saljö, R., & Östman, L. (Eds). (2013). *Scientific literacy – Teori och praktik.*

Knekta, E., Almarlind, P., & Ottander, C. (2022). The purpose of science education: Guidance provided by Swedish science syllabuses. *NorDiNa: Nordic Studies in Science Education*, *18*(1), 39–62. https://doi.org/10.5617/nordina.8224

Kurtiç, E. (2022). Criminalizing environmental activism in Turkey. Middle East Briefs, 147, 33947.

Marty, L., Venturini, P., & Almqvist, J. (2018). Teaching traditions in science education in Switzerland, Sweden and France: A comparative analysis of three curricula. *European Educational Research Journal*, *17*(1), 51–70. https://doi.org/10.1177/1474904117698710

Mashoko, D. (2022). Indigenous artefacts and physics curriculum: teaching science as a cultural way of knowing. *Cultural Studies of Science Education, 17*(3), 863–874. https://doi.org/10.1007/s11422-021-10085-1

Moore, F. M. (2007). Agency, identity, and social justice education: preservice teachers' thoughts on becoming agents of change in urban elementary science classrooms. *Research in Science Education, 38*(5), 589–610. https://doi.org/10.1007/s11165-007-9065-6

Milli Egitim Bakanligi (M.E.B.) (2000). Ilkögretim Okulu Fen Bilgisi Dersi Öğretim Programı. *M.E.B Tebliğler Dergisi, 63*, 2518.

Norambuena-Meléndez, M., Guerrero, G. R., & González-Weil, C. (2023). What is meant by scientific literacy in the curriculum? A comparative analysis between Bolivia and Chile. *Cultural Studies of Science Education*, *18*(3), 937–958. https://doi.org/10.1007/s11422-023-10190-3

Noy, C. (2008). Sampling knowledge: The hermeneutics of snowball sampling in qualitative research. *International Journal of Social Research Methodology*, *11*(4), 327–344. https://doi.org/10.1080/13645570701401305

Olander, C. (2013). Why am I learning evolution? Pointers towards enacted scientific literacy. *Journal of Biological Education*, *47*(3), 175–181. https://doi.org/10.1080/00219266.2013.821750

Osborne, J. (2023). Science, scientific literacy, and science education. In N. G. Lederman, D. L. Zeidler, & J. S. Lederman (Eds.), Handbook of research on science education. Routledge. https://doi.org/10.4324/9780367855758

Özden, B., & Yenice, N. (2022). The relationship between scientific inquiry and communication skills with beliefs about the nature of science of pre-service science teachers. *Participatory Educational Research*, *9*(1), 192–213. https://doi.org/10.17275/per.22.11.9.1

Rasmussen, J. and Rash-Christensen, A. (2015). How to improve the relationship between theory and practice in teacher education. *Educational Research for Policy and Practice, 14*(3), 213–230. https://doi.org/10.1007/s10671-015-9180-5

Roberts , D. A. (1982) . Developing the concept of 'curriculum emphases' in science education . *Science Education , 66* (2), 243–260 . https://doi.org/10.1002/sce.3730660209

Roberts, D. A. (2007). Scientific literacy/science literacy. In S. Abell and N. G. Lederman (Eds), *Handbook of research on science education*. Mahwah, NJ: Lawrence Erlbaum, pp. 729–80. https://doi.org/10.4324/9780203824696

Rundgren, C. J. (2018). Implementation of inquiry-based science education in different countries: some reflections. *Cultural Studies of Science Education*, *13*, 607–615. https://doi.org/10.1007/s11422-016-9787-8

Rundgren, S. C., Sun, Y., & Jidesjö, A. (2019). Examining gender differences in students' entrance into and persistence in STEM programs in Swedish higher education. *The European Journal of Educational Sciences, 06*(01). https://doi.org/10.19044/ejes.v6no1a5

Sjöström, J., & Eilks, I. (2018). Reconsidering different visions of scientific literacy and science education based on the concept of Bildung. *Cognition, metacognition, and culture in STEM education: Learning, teaching and assessment*, 65–88. https://doi.org/10.1007/978-3-319-66659-4_4

Sjöström, J. (2024). Vision III of scientific literacy and science education: an alternative vision for science education emphasising the ethico-socio-political and relational-existential. *Studies in Science Education, 61*(2), 239–274. https://doi.org/10.1080/03057267.2024.2405229

Skolinspektionen. (2011). Skolinspektionens rapport 2011:9. Fysik i mellanåren – bortgömt men inte bortglömt. Rapport om undervisningen i fysik i de mellersta skolåren. [Schools Inspectorate Report 2011: 9. Physics in the middle years – Hidden but not forgotten. Report on the teaching of physics in the middle school years.] Stockholm: Skolinspektionen.

Smith, K. V., Loughran, J., Berry, A., & Dimitrakopoulos, C. (2012). Developing scientific literacy in a primary school. *International Journal of Science Education*, *34*(1), 127–152. https://doi.org/10.1080/09500693.2011.565088

Streller, S. & Bolte, C. (2018). Becoming a chemistry teacher – Expectations for chemistry education courses. *Nordic Studies in Science Education*, *14*(2). https://doi.org/10.5617/nordina.6162

Türk, N., Kalaycı, N., & Yamak, H. (2018). New trends in higher education in the globalizing world: STEM in teacher education. *Universal Journal of Educational Research, 6*(6), pp. 1286-1304. https://doi.org/10.13189/ujer.2018.060620

Velthuis, C., Fisser, P., & Pieters, J. (2014). Teacher training and pre-service primary teachers' self-efficacy for science teaching. *Journal of Science Teacher Education, 25*(4), 445–464. https://doi.org/10.1007/s10972-013-9363-y

Yavuzkaya, M., Hasslöf, H., & Sjöström, J. (2025). Becoming a science teacher in the Anthropocene:Scientific knowledge as 'matters of concern'. *International Journal of Science Education*, *47*(12), 1496–1516. https://doi.org/10.1080/09500693.2024.2367174

YÖK (n.d.). Kurumsal Görev ve Yetkiler. Retrieved on 26 May 2024, from https://denetleme.yok.gov.tr/kurumsal/gorev-ve-yetkiler

Zhang, E. Y., Hundley, C., Watson, Z., Farah, F., Bunnell, S., & Kristensen, T. (2023). Learning by doing: A multi-level analysis of the impact of citizen science education. *Science Education, 107*(5), 1324–1351. https://doi.org/10.1002/sce.21810