frontiers in Education

TYPE Original Research
PUBLISHED 30 October 2026
DOI 10.3389/feduc.2026.1849607

Check for updates

OPEN ACCESS

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RECEIVED 07 April 2026
REVISED 29 August 2026
ACCEPTED 11 October 2026
PUBLISHED 30 October 2026

CITATION
Önal İ and Erişen Y (2026) Preparing pre-service teachers for critical thinking and its teaching: dispositions and teaching-related outcomes.
Front. Educ. 11:1849607.
doi: 10.3389/feduc.2026.1849607

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Preparing pre-service teachers for critical thinking and its teaching: dispositions and teaching-related outcomes

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Developing individuals with strong critical thinking skills is a key priority for today's societies and education systems. This study examines the impact of critical thinking training on pre-service teachers' critical thinking dispositions, attitudes, and views toward teaching critical thinking. An embedded experimental design within a mixed-method approach was employed using a single-group intervention. The participants consisted of 28 s-year social studies pre-service teachers enrolled in a state university in Turkey. The training was implemented over 9 weeks, comprising 18 class hours. Data were collected using the Critical Thinking Disposition Scale, an Attitude Scale towards Teaching Critical Thinking developed by the researchers, and a semi-structured interview form. Quantitative data were analyzed using appropriate parametric and non-parametric techniques while qualitative data were analyzed through content analysis. The results revealed significant improvements in participants' critical thinking dispositions and their attitudes toward teaching critical thinking. Qualitative findings indicated enhanced understanding, awareness, and instructional competencies related to critical thinking. These findings highlight the potential of structured training programs to support the integration of critical thinking into teacher education.

KEYWORDS
critical thinking, dispositions, mixed-methods design, pre-service teachers, teacher education

1 Introduction

In today's complex and rapidly changing world, critical thinking (CT) is widely regarded as a key competence that enables individuals to make meaningful contributions to their social, political, and economic lives. In modern and democratic societies, CT is mostly important for addressing controversial issues, as it allows individuals to define and solve world problems actively, justify their positions, and consider multiple perspectives (Glaser, 1941, p.5). It is regarded as a fundamental competency for lifelong learning, responsible citizenship, and addressing complex social challenges, as it enables individuals to evaluate information, question assumptions, analyze evidence, and make informed decisions (Anderson, 2023; Mellado-Moreno and Burgos, 2025; UNESCO, 2024). Beyond democratic participation (Vaughn, 2008), CT encourages individuals to make independent and accurate decisions and to actively solve the everyday life problems (Gürkaynak et al., 2009; Paul and Elder, 2006;Waghid, 2024). Moreover, CT is seen to be related to long-term

success in both professional life (Hyytinen et al., 2024). International organizations identify CT as one of the core skills needed in the future labor market (Organization for Economic Cooperation and Development [OECD], 2019; Schleicher, 2016; World Economic Forum [WEF], 2023).

Given its importance in both personal and professional life, critical thinking is a skill that every individual should acquire; however, developing CT independently is quite diffucult for most individuals (Korkmaz, 2009; Wang et al., 2026). Evidence from OECD countries indicates that students' CT development frequently remains below expected levels, even within higher education settings (Bouckaert, 2023). Previous research indicate that informal learning from peers or parents is generally insufficient for cultivating CT, highlighting the need for planned instructional activities within formal education (Gul, et al., 2014; Kestel, 2022; Schafersman, 1991). Indeed, CT, which is accepted as a fundamental educational goal (Cevizci, 2010; Halpern, 2014; Scriven, 1985), has become the focus of curriculum reforms in many countries worldwide (Care, et al., 2018; Saldıray and Doğanay, 2024). However, simply including CT skills in curricula is not sufficient; appropriate teaching strategies and structured learning activities are needed to effectively reflect these skills and dispositions in classroom (Bedir, 2016; Lombardi et al., 2022). In this process, teacher quality is seen as one of the most decisive factors in achieving the goals of the reforms and effectively implementing CT in schools (Aybek, 2006; Glewwe et al., 2013). Recent research highlights that teacher quality, when underpinned by strong pre-service teacher education and professional preparation, is a key factor in educational improvement and in the effective development of students' critical thinking competencies (OECD, 2025, p.8; Bubikova-Moan et al., 2026).

CT is indispensable for individuals working in professions directly related to human life such as teachers (Finkelman, 2001). At the same time teachers are responsible for developing CT in their students through activities such as accessing and evaluating information, and this competency is emphasized as a core teacher competency within the scope of TALIS with the statement "helping students think critically" (Garcia et al., 2026; OECD, 2018).

Research in teaching CT has revealed that teachers are reluctant and feel inadequate in both theoretical and practical aspects (Baysal et al., 2017; Gürbüz, 2016; İnan and Özgen, 2008; Kaya, 2008; Mok, 2010; Mutlu, 2010; Polat, 2015; Stephen, 2011). They lack sufficient knowledge for methods to incorporate CT into their activities (Ali and Awan, 2021; Behar-Horenstein and Niu, 2011; Bekcan et al., 2023; El Soufi and See, 2019; Gashan, 2015; Saito and Tangkiengsirisin, 2023; Tsui, 2002). Similarly, studies have shown that pre-service teachers are not adequately trained to incorporate CT into their classroom teaching (Chen et al., 2024; Gashan, 2015; Wagley, 2013; Yeşilpınar and Doğanay, 2014). They have not even developed a clear understanding of CT (Petek and Bedir, 2018). Altun and Yıldırım (2023) have argued that pre-service teachers lack knowledge regarding dispositions of CT. At the same time, recent intervention studies indicate that these shortcomings can be addressed through structured training programs specifically designed to foster critical thinking development among pre-service teachers (Lupión-Cobos et al., 2026; Sutoyo, 2023). Accordingly, recent reviews have emphasized the need for further research to support teachers in effectively cultivating students' CT skills (Wang et al., 2026; Yurt, 2024).

Pre-service teachers' orientation towards appropriate methods for teaching CT is closely related to developing a clear understanding of CT (Petek and Bedir, 2018) and showing positive dispositions towards CT (Halpern, 2014). Nevertheless, a systematic review by Taştı and Yıldırım (2022) indicated that the development of CT dispositions remains insufficiently addressed within teacher education programs. CT dispositions also enable pre-service teachers to develop skills such as inference and evaluation in their students (Altun and Yıldırım, 2023). Dispositions such as open-mindedness, intellectual humility, and willingness to self-evaluate are fundamental to developing both personal and pedagogical applications of CT (Facione, 1990; Halpern, 2014). Therefore, teacher education programs should enhance the CT dispositions of pre-service teachers while equipping them with professional competencies related to the instruction of CT (Akdere, 2012; Aktoprak and Hursen, 2022; Alkın, 2012; Chen et al., 2024; Chiodo and Tsai, 1997; Gashan, 2015; Gomendio, 2017; Karadeniz, 2006; Wagley, 2013; Yeşilpınar and Doğanay, 2014). However, despite these widely acknowledged needs, there are some challenges in preparing pre-service teachers to teach CT (Pedraja-Rejas et al., 2025).

In particular, the literature highlights various factors that prevent pre-service teachers from being effectively prepared to teach CT. Gashan (2015) stated that although they have positive attitudes toward CT, their knowledge of this subject is limited. In general, previous research indicates that pre-service teachers know what CT is and why it is important (Asgharheidari and Tahriri, 2015; El Soufi and See, 2019; Saito and Tangkiengsirisin, 2023); but cannot concretely explain the skills and dispositions of CT (Altun and Yıldırım, 2023; Chen et al., 2024; Kurnaz and Arslantaş, 2015; Ömeroğlu and Hakkoymaz, 2025).

Such limitations in pre-service teachers' understanding of CT are generally associated with deficiencies in teacher education curricula and teaching practices (Aldan Karademir and Saracaloğlu, 2017; Lipman, 2003; Önal and Erişen, 2019). In this context, the limited knowledge of faculty members regarding CT and its teaching (Wagley, 2013) and the lack of sample curricula or course applications emerge as significant problems. Recent intervention-based studies have demonstrated that structured learning experiences can significantly enhance pre-service teachers' CT dispositions (Ömeroğlu and Hakkoymaz, 2025). Therefore, it is also necessary to strengthen teacher education programs with structured curricula to prepare pre-service teachers to effectively teach CT in their future classrooms (Gul et al., 2014; Williams, 2005).

Despite this need for structured and practice-oriented approaches, research on CT in teacher education has largely focused on theoretical issues. In their bibliometric analysis, Wang and Jia (2023) have examined the research conducted over the past 20 years on teachers' critical thinking. Accordingly, research has focused on the theoretical aspect of CT, and practical applications and experimental studies are still limited (Bubikova-Moan et al., 2026). Similarly, Prayogi et al. (2018) suggest that learning interventions are the most effective

approach to promote CT skills during pre-service teacher education.

In response to these gaps, this study aims to address the lack of experimental and practice-oriented research by examining the effects of a structured critical thinking training program on pre-service teachers' CT dispositions and their dispositions toward teaching CT. To provide a clearer understanding of the subject, the following section offers a comprehensive review of the concept of CT within the relevant literature.

1.1 Overview of critical thinking

CT is the process of making reasoned judgments by evaluating claims, arguments, and opinions according to specific standards (Nosich, 1985; Ruggiero, 2016). As an intellectual attitude (Cevizci, 2010) CT involves active and persistent thinking in which the individual mentally engaged (Dewey, 1910); criterion-based, self-correcting, self-controlled, and context-sensitive reasoning (Facione, 1990; Glaser, 1941; McKown, 1997; Lipman, 1988) It requires purposeful thinking for making the best possible decisions about what to believe or how to act (Paul, 1993).

CT consists of two dimensions: dispositions and skills. CT skills include evaluating the reliability of sources, recognizing inconsistent judgments (Kökdemir, 2012), evaluating evidence and arguments, and drawing conclusions (Facione, 1990). Effective CT requires the simultaneous presence of both dispositions and skills (Bailin, 2002; Pedraja-Rejas et al., 2025). Indeed, even if individuals possess CT skills, they may not be able to use these skills effectively unless they develop a disposition to question their assumptions, seek evidence, or evaluate differing viewpoints (Butler, 2024). Therefore, dispositions are considered one of the fundamental elements that enable the functional use of CT skills.

CT dispositions, also referred to as mental attitudes, habits, or intellectual virtues, are defined as individuals' willingness to think critically (Zhang, 2003). The literature commonly identifies dispositions such as open-mindedness, truth-seeking, objectivity, independent thinking, intellectual curiosity, willingness to question assumptions, seeking evidence, reflectiveness, and perseverance as core components of CT (Bailin et al., 1999; Chaffee, 2012; Ennis, 1985; Ennis, 1991; Facione, 1990; Nosich, 2018; Perkins et al., 1993; Ritchhart, 2002).

Recent research indicates that CT dispositions are a key component of effective teacher education, as they are associated with higher academic achievement, stronger professional judgement and decision-making, and the capacity to create learning environments that foster CT in students (Bubikova-Moan et al., 2026; Flores and Quilestino, 2026; Kumandaş-Öztürk and Ulu-Kalın, 2025). Teachers' CT dispositions influence the teaching strategies they use in the classroom and the ways they support student thinking (Garcia et al., 2026; Pedraja-Rejas et al., 2025; Waghid, 2024; Yurt, 2023); they also contribute to teachers' ability to assess complex educational situations and make effective pedagogical decisions (Zhao and Ai, 2026).

1.2 Critical thinking in education context

CT should be taught clearly and systematically within the framework of general, subject-based, or mixed approaches; students' processes of analysis, evaluation, reasoning, and consideration of different perspectives should be supported through active and student-centered methods such as Socratic inquiry, discussion, problem-solving, case studies, collaborative learning, and authentic tasks (Abrami et al., 2015; Ennis, 1989). In assessing CT, in addition to traditional tests, performance-based assessment methods such as written tasks, observation, and rubrics that demonstrate students' ability to use these skills in meaningful contexts should be utilized (Hyytinen et al., 2024; Lai, 2011; McEwen, 1994). How these approaches are incorporated into curricula varies from country to country.

CT has become a cornerstone of global educational reforms due to its significance in individuals' social and professional success. For instance, the Canadian Learning Vision Document identifies CT as one of the essential skills for students in the 21st century (Canadians for 21st Century Learning and Innovation, 2012), leading to its integration into national curricula. Similarly, Singapore renewed its 21st Century Competencies and Student Outcomes framework to include CT (OECD, 2018). Japan has pursued educational reforms emphasizing CT since the 1990s (Howe, 2004). In line with international trends (Eurydice, 2008), Turkey's 2005 education reform also has embedded CT within its national curricula.

In Turkey, CT was identified as one of the eight common skills in the curricula developed by the Ministry of National Education (MONE) in 2005, grounded in the progressive education philosophy (Baysal et al., 2010; Duru and Korkmaz, 2010, p.71). Since then, CT was included either explicitly or implicitly in the specific aims and learning outcomes of the curricula from preschool to secondary education (Sezgin et al., 2018; Ünveren Kapanadze, 2019). To further promote CT, the elective Thinking Education course was first introduced in the 6th grade in the 2006–2007 academic year (Milli Eğitim Bakanlığı, 2016; Ülger, 2012). Since the 2017–2018 academic year, the course has been offered as a two-hour elective in the 7th and 8th grades, and as of the 2023–2024 academic year, it has been also introduced in the 5th and 6th grades. Additionally, the course is offered in the 9th and 10th grades at the high school level (Milli Eğitim Bakanlığı, 2023a, 2023b). One of the primary aims of this course is "to foster students with CT skills through doubt and questioning." Some of the learning outcomes include developing a questioning and critical stance; examining the relationship between claims and facts; reliability of information; using evidence to support and refute arguments (Milli Eğitim Bakanlığı, 2016). Overall, it is indicated that the Turkish education system has adopted a mixed-approach

Parallel to curriculum reforms in Turkey, teacher education programs have also undergone revisions. The following statement is included in the Teacher General Competencies document of the MONE: B2.6. It creates learning environments that develop students' higher-order thinking skills. This competency positions the cultivation of thinking skills among students as a fundamental responsibility of teachers (Öğretmen Yetiştirme ve Geliştirme Genel Müdürlüğü, 2017).

As part of the 2018 revisions to teacher education programs in Turkey, a two-hour elective course titled *Critical and Analytical Thinking* was introduced across all teacher education programs. The Council of Higher Education provides a brief description of the course content within the undergraduate programs. However, limited information is available regarding how the course is implemented, including its instructional design, aims, pedagogical approaches, learning activities, and evaluation process. Moreover, it remains unclear what type of instruction is currently delivered within the scope of this course in faculties of education.

As a result, it is indicated that the Turkish education system has adopted a mixed-approach to teaching CT, integrating it into both subject-specific and subject-independent courses across educational levels. Nevertheless, there is a need to determine to what extent CT is effectively taught in schools.

1.3 Rational of the study

International large-scale assessments such as the PISA (The Program for International Student Assessment) and TIMMS (Trends in International Mathematics and Science Study) provide indicators of the extent to which CT is developed in schools (Yalçın, 2018, p.188). According to the PISA results for 2018 and 2022, Turkey performs below the OECD average at levels 5 and 6, where advanced thinking skills, such as reasoning and critical analysis, are assessed (Milli Eğitim Bakanlığı, 2023c; Schleicher, 2019). Similarly, the World Bank's CT in Education report indicates that while countries such as Denmark and Finland score 5.58 on a 1–7 scale, Turkey's score is 2.42, showing limited development of CT skills.

Although thinking skills are emphasized within Turkish curricula, students' limited scores in international assessments suggest that the curriculum alone may be insufficient. It follows that other variables, such as teacher-related factors, are also important.

Teacher quality is recognized as one of the most effective in-school factors in student achievement (Aybek, 2006; Ennis, 1991; Glewwe et al., 2013). The studies highlight the importance of well-designed instructional activities and teacher competence in fostering students' CT dispositions and skills. Therefore, both in-service and pre-service teachers need to possess theoretical knowledge of CT as well as competence to cultivate it effectively in the classroom. However, research indicates that many pre-service teachers lack sufficient knowledge, understanding, or practical experience in teaching CT (Baysal et al., 2017; Paul, Elder and Bartell, 1997; Stephen, 2011; Wagley, 2013).

Furthermore, only a limited number of studies have focused on structured training programs for improving teachers' (Alkın, 2012; Dolapcı, 2009; Ünlü, 2017) and pre-service teachers' (Petek and Bedir, 2018; Vong and Kaewurai, 2017; Yang, 2012; Yeh, 1997) competence in fostering CT skills.

For CT to be effectively implemented at all levels of education, pre-service teachers must receive comprehensive preparation (Deringöl, 2017; Kaloç, 2005; Mutlu and Aktan, 2011; Serin, 2013; Walsh and Paul, 1986). Throughout their training, they should develop awareness and understanding of both the cognitive and affective dimensions of CT, and learn how to employ instructional strategies, methods, techniques, and measurement tools that promote CT.

In Turkey, research on pre-service teachers' CT primarily focuses on determining their current skill and dispositions levels, highlighting the need for intervention-based studies that examine how these skills and aptitudes can be developed (Taştı and Yıldırım, 2022). Similarly, current international research reveals that significant differences persist in the conceptualization and approach to CT in teacher education (Bubikova-Moan et al., 2026), particularly highlighting the ongoing debate in the literature regarding how to teach and assess CT, and the continuing theory-practice gap (Toncel Herrera and Jiménez Sierra, 2026). Accordingly, this study contributes to the literature by developing a structured educational program that integrates the theoretical foundations, skills and dispositions, teaching practices, and assessment approaches of CT, and by empirically evaluating the effectiveness of this program.

In response to this need, the main purpose of this study is to examine the effectiveness of a training program designed to improve pre-service teachers' CT dispositions, attitudes towards teaching CT, and their understanding and perceived competence in teaching CT. The study addresses the following research questions:

1. Is there a significant difference between the participants' pre-test and post-test scores in terms of critical thinking disposition?
2. Is there a significant difference between the participants' pre-test and post-test scores in terms of their attitude towards teaching critical thinking?
3. How does the training influence the participants' views on teaching critical thinking?

2 Research methodology

2.1 Design

This study is an applied, intervention-based experimental research. It employed an embedded experimental design, in which qualitative data were collected before, during, and after the experimental process (Creswell and Plano Clark, 2015, pp. 100–103). In embedded designs, the researcher embeds qualitative data within quantitative data by explaining participants' views and experiences related to the intervention, thereby strengthening the interpretation of experimental outcomes (Creswell, 2002, p. 558). The research was structured as a single-group pretest-posttest experimental design, primarily based on quantitative data. Qualitative findings were used in conjunction with quantitative data to enrich the findings. As noted by Cohenet al. (2007), p. 282, single-group experimental designs are commonly employed aimed at developing and implementing new instructional methods or programs. The theoretical framework of the study was constructed in alignment with conceptual perspectives and empirical research findings in the field of CT.

2.2 Participants

The experimental intervention was conducted with 28 s-year pre-service social studies teachers (11 female and 17 male) enrolled in the faculty of education at a state university in Turkey during the spring semester of the 2018–2019 academic year. The sample size was determined by the number of students enrolled in the course who regularly attended the sessions throughout the intervention period. The demographic characteristics of the participants are presented in Table 1.

Table 1 presents the gender and age distribution of the participants. The majority of participants were male (60.7%), while females represented 39.3% of the sample. Among age groups, 21-year-old participants constituted the largest subgroup (42.9%). In addition, five participants (17.8%) were selected for the interviews, which served as the qualitative data source for the study. Interview participants were primarily selected based on their willingness to participate in both the pre- and post-interviews; regular class attendance and gender diversity were also considered in the selection process.

2.3 Data collection tools

Data were collected using three instruments: the Critical Thinking Disposition Scale developed by Semerci (2016), the "Attitude Scale Towards Teaching Critical Thinking" developed by the authors, and a semi-structured interview form.

Critical Thinking Disposition Scale: Semerci (2016) developed this scale to determine the CT dispositions of pre-service teachers. The scale consists of five dimensions: metacognition, flexibility, systematicity, perseverance-patience, and open-mindedness. There are a total of 49 positive items across all dimensions. Responses are recorded on a 5-point Likert scale ranging from 1 (Disagree) to 5 (Agree). In Semerci's (2016) study, the Cronbach's alpha coefficients were reported as.89 for metacognition,.89 for flexibility,.90 for systematicity,.83 for perseverance-patience dimension, and.67 for open-mindedness. In the present study, the reliability coefficients for entire scale were found to be.95 for the pre-test and.94 for the post-test. Pre-test and post-test reliability coefficients for the subdimensions ranged between.66 and.88, indicating acceptable to high internal consistency (Morgan et al., 2007, p.131).

TABLE 1 Demographic characteristics of the participants .

Variable	Intervention Group	
	n	%
Gender		
Female	11	39.3
Male	17	60.7
Age		
≤ 20	10	35.7
21	12	42.9
22	2	7.1
≥ 23	4	14.9
Total	28	100

Attitude Scale towards Teaching Critical Thinking: The authors first created a conceptual framework, followed by a draft form comprising 23 items based on expert feedback. This draft was administered to 202 pre-service teachers for exploratory factor analysis (Ho, 2006, p. 244; Kline, 1994, p. 22; Thompson, 2004, p. 22). The Kaiser-Meyer-Olkin (KMO) coefficient was 0.86, and the Bartlett's Test of Sphericity was significant (χ^2=1383.812; $p < 0.05$), indicating suitability for factor analysis. Scree plot graph analysis indicated a single-factor structure. Items with inadequate psychometric properties were removed. Following the removal of the four items, the scale was finalized with 19 items. The single factor with an eigenvalue of 6.7 explained 35.55% of the total variance (Büyüköztürk, 2007, p. 125). The Cronbach's alpha coefficient for the finalized scale was checked.885, indicating high internal consistency (Ho, 2006, p. 288).

Confirmatory factor analysis (CFA) further validated the single-factor structure. The χ^2/df ratio was 1.25, which was below 2, indicating a perfect fit. The RMSEA value of 0.042, which is less than 0.05, confirms an excellent fit. The NNFI and CFI values exceeded 0.95 (perfect fit), the NFI value indicated a good fit, and the GFI value was at an acceptable level. The standardized RMR value of less than 0.08 also indicated a good fit. As Brown (2015, p. 71) states the SRMR values closer to 0 suggest a better fit. The finalized 19-item scale has two reverse-coded items. Responses are recorded on a 5-point Likert scale ranging from 1(Totally Disagree) to 5 (Totally Agree), yielding total scores between 19 and 95. In the present study, Cronbach's alpha coefficients were 0.92 (pre-test) and 0.93 (post-test), indicating strong reliability.

Semi-Structured Interview Form: The authors developed a semi-structured interview to collect qualitative data. The form consisted of 17 open-ended questions and was administered both before and after the intervention. This semi-structured interview form was developed to deeply examine the changes in pre-service teachers' knowledge, opinions, and perceptions regarding critical thinking and its teaching after training. The form was prepared based on relevant literature and research objectives, the suitability of the questions was evaluated, and the form was finalized following a pilot study. Sample questions include: "What kind of learning environment should be created to foster critical thinking?", "How can students' critical thinking be assessed?", and "To what extent do you consider yourself competent in teaching critical thinking?" The same questions were administered before and after the intervention to enable a direct comparison of changes in participants' knowledge, views, and perceptions regarding CT and its teaching over the course of the training.

2.4 Context, program and implementation procedures

The researchers developed a Critical Thinking Course Program based on a needs analysis and on an established conceptual framework of CT. Within the scope of the needs analysis, a 5-point Likert-type questionnaire applied to 3rd and

TABLE 2 Critical thinking course program (9-week implementation overview).

Week	Content	Objectives	Instructional activities
Week1	Course Introduction	1.1. Introduction to the course structure	Introduction to the course scope and procedure; Administration of pre-tests, initial interviews
Week2	Introduction to CT	2.1. Explain key CT concepts and terminology 2.2. Analyze the role of CT in education	Discussion of CT definitions, thinkers, classroom environments that supports CT
Week3	Affective Characteristics of CT	3.1. Analyze affective characteristics of CT 3.2. Value intellectual virtues	Discussion of prejudice and individual differences; creation of intellectual virtue posters
Week4	Cognitive Skills in CT	4.1. Explain cognitive dimension of CT 4.2. Analyze logical structure of basic concepts related to CT skills 4.3. Identify barriers to CT development 4.4. Recognize invalid reasoning (fallacies)	Discussion of basic concepts of CT (truth, claim, etc.) Discussion of CT skills, A product is marketed using examples of invalid reasoning
Week5	Standards and Elements of CT	5.1. Explain CT standards 5.2. Explain elements of CT	Guided explanation and application of CT standards and elements
Week6	Questioning and Socratic Questioning	6.1. Formulate questions enhancing CT 6.2. Apply Socratic questioning techniques	Questions generation and categorization based on a sample text Analysis through critical questioning; Socratic circle discussion
Week7	Teaching CT: Methods and Techniques	7.1. Compare the instructional strategies, methods and techniques used in teaching CT	Application of CT methods and techniques.
Week8	Measurement and Assessment of CT	8.1. Examine assessment tools for CT 8.2. Discuss the importance of measurement and evaluation in teaching CT	Discussion of measurement and assessment in CT teaching Development of an observation form for teaching CT in the classroom
Week9	Course Evaluation	9.1. Present observation forms, reports 9.2. Reflection on CT development and course process	Submission of reports Administration of post-tests, final interviews

4th-grade pre-service teachers determined the importance they attributed to CT teaching strategies and their perceived competence in applying them. The findings indicated that pre-service teachers were inadequate in integrating CT into their lessons and demonstrated a need for improvement in both attitudes and instructional competencies regarding CT strategies.

The primary aim of the program was to introduce pre-service teachers to CT skills, dispositions, standards, elements, and instructional strategies. In addition, the program sought to equip participants with the knowledge and skills necessary to design instruction that promotes CT within their disciplinary field.

The intervention was implemented over nine weeks (18 instructional hours). Researchers developed a detailed weekly lesson plan that included specific objectives, content, methods and techniques, materials, and introduction–development–closure activities. Table 2 summarizes the scope and structure of the program.

After obtaining ethics committee approval (Institution: Akdeniz University, Social and Human Sciences Social and Scientific Research and Publication Ethics Committee, Approval Number: 40, Approval Date: 01/03/2019), along with the necessary institutional permissions. The program was conducted with 28 pre-service teachers during the spring semester of the 2018–2019 academic year. Ornstein and Hunkins (2018) emphasized that effective curriculum implementation requires trained practitioners. Therefore, the researcher who delivered the intervention completed a 15-week online training on integrating CT into teaching, offered by the Critical Thinking Foundation (USA) in 2018.

2.5 Data collection and analysis

The researchers collected both quantitative and qualitative data in the study. The CT Disposition Scale and the Attitude Towards Teaching CT Scale were administered as pre-tests and post-tests.

Since the CT Disposition scores met the normality assumption, the paired samples t-tests were conducted to compare pre- and post-test scores. Wilcoxon signed-rank test was employed for the mean scores of the Attitude Towards Teaching CT Scale; the assumption of normality was not satisfied. The level of significance was set at.05 for all statistical analyses. Descriptive and inferential analyses were performed using SPSS 22.0.

Qualitative data were collected through semi-structured interviews conducted with five pre-service teachers before and after the intervention. Content analysis was used to analyze the participants' views. To ensure reliability, 10% of the data were independently coded by an expert in qualitative research. Subsequently, the evaluators compared the resulting codes and themes and created a code list that served as a guide in the analysis of the remaining data (Babbie, 2010). To ensure credibility, the interview transcripts were shared with participants via e-mail for member checking (Yıldırım and Şimşek, 2013). Additionally, a peer reviewer experienced in qualitative research reviewed the analysis process (Krefting, 1991). For transferability and confirmability, the authors ensured transparency by describing findings in detail with direct quotations, and by preserving participant anonymity (Graneheim and Lundman, 2004, p. 110).

3 Results

This study examined the effects of CT training on pre-service teachers' CT dispositions, attitudes, and views towards teaching CT. The following section presents and interprets the findings in relation to the research questions.

3.1 Findings related to critical thinking dispositions

In relation to the first research question, whether the CT training led to a significant change in participants' CT dispositions was examined. The analysis (see Table 3) revealed a statistically significant difference between the participants' pre-test and post-test mean scores on the Critical Thinking Disposition Scale [$t(27) = -3.546$, $p < 0.05$].

The pre- and post-test mean scores of the participants for the metacognition dimension were found to be statistically significantly different [$t(27) = -2.120$, $p < 0.05$]. Similarly, significant differences were observed between the pre- and post-mean scores for the flexibility dimension [$t(27) = -2.667$, $p < 0.05$], as well as the systematicity dimension [$t(27) = -3.626$, $p < 0.05$]. A significant difference was also found for the open-mindedness dimension [$t(27) = -2.929$, $p < 0.05$]. However, no significant difference was found between the pre- and post-test mean scores for the perseverance-patience [$t(27) = -1.748$, $p > 0.05$].

The post-test mean scores of the participants were higher than their pre-test scores in all dimensions: metacognition (M = 4.28 vs. 4.16), flexibility (M = 4.20 vs. 4.03), systematicity (M = 4.12 vs. 3.90), perseverance-patience (M = 3.96 vs. 3.80), and open-mindedness (M = 4.34 vs. 4.04). These results indicate that the training led to significant improvements in the total scores and all dimensions except for perseverance-patience. Also the program's effect on CT dispositions was found to be moderate (Cohen's $d^z = 0.67$) in terms of total score (Cohen, 1988).

3.2 Findings related to attitudes towards teaching critical thinking

The arithmetic means of the Attitudes Toward Teaching Critical Thinking Scale are presented in Table 4. As shown, post-test mean scores (M = 4.62, SD = 0.40) were higher than the pre-test mean scores (M = 4.39, SD = 0.54). Consistent with the Wilcoxon test results, the training significantly improved participants' attitudes toward teaching CT.

A Wilcoxon signed-rank test results (see Table 5) revealed a significant increase in participants' attitudes towards teaching CT [$z = -3.102$; $p = 0.02$; $p < 0.05$].

3.3 Findings related to pre-service teachers' views on teaching critical thinking following training

The third research question explored the effects of CT training on pre-service teachers' views regarding CT and its instruction. Semi-structured interviews were conducted with five pre-service

TABLE 3 Paired samples t-test results for critical thinking dispositions ($N = 28$).

Dimension	Group	*n*	M	SD	t(27)	*p*	Cohen's d (d^z)
Metacognition	Pre-test	28	4.16	0.40	−2.120	0.040	
	Post-test		4.28	0.42			0.40
Flexibility	Pre-test	28	4.03	0.44	−2.667	0.010	
	Post-test		4.20	0.49			0.50
Systematicity	Pre-test	28	3.90	0.46	−3.626	<0.001	
	Post-test		4.12	0.48			0.69
Perseverance-patience	Pre-test	28	3.80	0.65	−1.748	0.090	
	Post-test		3.96	0.60			0.33
Open-mindedness	Pre-test	28	4.04	0.65	−2.920	<0.001	
	Post-test		4.34	0.57			0.55
Total score	Pre-test	28	4.00	0.43	−3.546	<0.001	
	Post-test		4.17	0.43			0.67

teachers (three females, two males; *M*age =21) before and after the intervention. To ensure confidentiality, participants were assigned the codes A, B, C, D, and E. The qualitative analysis of the interview data revealed two main themes: CT skills and perspectives on teaching CT.

3.3.1 Theme of critical thinking skills

Under the theme of CT skills, two categories emerged: cognitive and affective dimensions. The codes and categories derived from the pre- and post-interviews, along with their frequencies, are presented in Table 6.

Table 6 indicates that the participants' conceptualizations of the cognitive and affective dimensions of CT became more enriched, and their understanding improved by the end of the intervention. In the pre-interviews, participants evaluated the cognitive skills of CT by considering the positive and negative aspects of an issue and possessing subject-matter knowledge. In contrast, post- interviews reflected a more comprehensive understanding, incorporating elements such as analysis, evaluation, and reflective judgment. The following quotes illustrate these findings:

> Participant A: … most people remain at the knowledge level. He may grasp knowledge, but he does not understand what lies behind it. However, synthesis, analysis, and evaluation are very different things. Going up to its upper dimension means examining it in more detail. I think people who have reached this level are critical thinkers. [cognitive_postinterview]
>
> Participant B: He needs to ask the other person to prove his point… [cognitive_postinterview]
>
> Participant E: We may say such people are open-minded, honest, and have intellectual standards. It occurs at that level. For example, he may be open to every idea, and you can trust him. A person who thinks critically rather than being prejudiced is more (mentally) humble. [affective_postinterview]

Overall, these findings indicate that participants have developed a broader understanding of the cognitive and affective dimensions of CT. References to elements such as analysis, evaluation, evidence, open-mindedness, and intellectual humility in the final interviews illustrate this more comprehensive conceptualization of CT.

3.3.2 Theme of teaching critical thinking

Under the theme of Teaching Critical Thinking, seven categories emerged: teachability, teacher role, methods and techniques, learning environment, evaluation, obstacles, and perception of competence. The codes and categories identified in the preliminary interviews regarding this theme are listed in Table 7, along with their frequencies.

According to the pre-interview findings, all pre-service teachers recognized CT as a teachable skill, although they reported feeling insufficiently competent to teach it. They associated CT instruction with student-centered activities, questioning, brainstorming, and discussion techniques. Additionally, they suggested using open-ended questions to assess students' CT. Participants also identified factors that hinder CT development, including the environment in which individuals grow up and the teacher's competence. The participants' statements are as follows:

> Participant A: It may be innate for us to understand to some extent, but I think it is something learned later. We can learn this by reading books or taking lessons from our teachers. [teachability]
>
> Participant E: We cannot assume they are all equal… the classroom environment should be that way. There should not be only one type of person. There should never be stereotypes. They have to come from different places. [learning environment]
>
> Participant C: … In fact, with his ability to express himself… [evaluation]
>
> Participant E: I am not sufficiently right now because of the education I received. [perception of competence]

Findings from the post-interviews (Table 8) indicate that the participants were able to provide more diverse and concrete examples for teaching and assessing CT.

Following the training, participants who initially perceived themselves as insufficiently competent to teach CT reported an increased sense of teaching competence. Selected statements are given below:

> Participant B: Particularly after taking this course, I realized that CT is a thinking skill that can be learned. It can be learned and taught to the student using various techniques. [teachability]
>
> Participant C: There was Socratic circle, and there was six thinking hats technique that we employed in class. [method-technique]

TABLE 4 Comparison of pre- and post-test mean scores on attitudes towards teaching critical thinking.

Group	*n*	M	SD
Pre-test	28	4.39	0.54
Post- test		4.62	0.40

TABLE 5 Wilcoxon signed-rank test comparing pre-test and post-test attitudes toward teaching critical thinking.

Group	Ranks	N	Mean rank	Sum of ranks	z	P
Pre-test Post-test	Negative Ranks	5	12.00	60	−3.102	.020
	Positive Ranks	22	14.45	318		
	Ties	1				
	Total	28				

TABLE 6 Pre- and post-interview findings on critical thinking skills.

Category	Codes	f	Participants	Category	Codes	f	Participants
Cognitive Pre-interviews	Evaluation with positive and negative aspects	10	A,B,C,E	Cognitive Post-interviews	Inquiry/Research	8	A,C,E
					Advancing to the evaluation stage in the cognitive field	5	A,C,E
					Seeking accuracy and validity	4	D,E
					Justifying opinions/ searching for evidence	4	B,D
					Graunding in causes and effects	4	E
					Higher-order thinking	2	A, B
	Knowledge about the subject	5	A,E		Objective evaluation	2	D,E
					Uncovering the underlying truth of events	2	A,C
					Making an assumption	1	B
					Presenting claims	1	D
					Exploring the mind by avoiding emotions	1	D
					Making comparisons between events	1	E
Affective Pre-interviews	Being open minded	5	A,B,E	Affective Post-interviews	Being open-minded	14	A,C,D,E
					Being unbiased	10	B,E
	Empathy	3	B, D		Being respectful	7	A,B,D,E
					Showing mpathy	5	B,C,D
	Neutral thinking	1	D		Effective listening	4	B
					Being honest	3	A,D
	Being tolerant	1	D		Avoiding egocentrism	3	A
					Being humble	2	A,E

Frequency (f) represents the total number of coded references to each category, not the number of participants; therefore, the same participant may contribute more than one coded reference to a category.

Participant B: There is a discussion technique. When we say discussion, we can call this technique not a discussion as such but rather evaluating the opinions of others fairly and democratically. [method-technique]

Participant D: There is an effective method of asking questions. Asking lower and higher level questions. Asking lower-level questions is just to improve knowledge and comprehension. At the higher level, analysis, synthesis, and evaluation can be improved. The six hats technique, Socratic questioning, and Socratic circle, which I am thinking of using. If I become (a teacher)… It sounds pretty fun… [method-technique]

Participant A: … Thinking that only your own thoughts are correct. Being lazy. Not liking productivity. I think thoughts like "Let someone else think for me" and things like taking someone else's ideas and implementing them can hinder a lot. [obstacles]

Participant E: Going to class and doing nothing… This dulls critical thinking. In class, just explaining the subject, explaining…. It is just a rote system.. If we could collate our thoughts and have them look at it from different people's perspectives, it would contribute to critical thinking, but when only information is given, this becomes rote. This does not improve at all. [obstacles]

Participant A: I'm not perfect in thinking and interpretation, but I think I have reached a good level. What we saw in class added a lot to us—especially techniques. I want to learn these in detail and employ them later. I think I have gone higher in terms of thinking. [perception of competence]

Participant B: It is a concept that I have encountered for the first time in the program, but not in my 13 years of education. I am also just learning what CT actually is. After taking this course, doing the homework, going to secondary school, and observing, I understood how I could teach it to students. I can say partially. Of course, I do not consider myself completely sufficient because I still have a long way to go, but I have partially learned about it. Because I am already very willing.. [perception of competence]

Participant C: I was at a much lower level in CT before taking this course. When I took this course, I realized some things. For example, how to develop critical thinking. I can do some things about this right now, but I need to improve myself as a teacher. Because the teacher is highly responsible for teaching CT in the classroom. I know that. I would like to see this type of courses offered at the high schools and our faculty. [perception of competence]

Participant D: "I am more effective than at the beginning of the semester. We learned methods and techniques. If we have the opportunity to practice these, we will use them. For example, I did not know the methods. If it happens, I plan to do them within the first year." [perception of competence]

Participant E: The course contributed a lot. We had a few ideas about CT but did not know how to implement them.

TABLE 7 Pre-interview findings on teaching critical thinking.

Categories	Codes	f	Participants
Teachability	Being eligible for teaching	5	A,B,C,D,E
Role of teachers	Empathize	3	B,C,D
	Conducting the course student-centered	3	A,C,E
	Asking exploratory questions	1	A
Methods and techniques	Theatre	3	A,B,D
	Brainstorming	2	E
	Transferring different cultures	1	D
	Discussion	1	E
Learning environment	Student-centered	8	B,C,E
	Tolerant	5	A,C,D,E
Assessment	Open-ended questions	2	A,B
	Students' self-expressions	2	C,E
	No answer	1	D
Barriers	Growing environment	5	A,B,D,E
	Teacher inadequancy	3	A,D,E
	Being closed-minded	2	A,E
	Fear of being ridiculed	1	A
	Pressure	1	C
Perception of competency	Not competent	5	A,B,C,D,E

Frequency (f) represents the total number of coded references to each category, not the number of participants; therefore, the same participant may contribute more than one coded reference to a category.

But now we have learned how to apply it and what to do. [perception of competence]

Overall, these findings indicate that after the training, participants' views on methods, learning environments, and assessment approaches that can be used in teaching CT became more diverse and detailed. They also show that they rate themselves more positively regarding the teaching of CT.

4 Discussion

The participants demonstrated high levels of CT dispositions at the beginning, which further increased following the training. However, due to the absence of a control group, it cannot be argued that the observed improvement is solely due to the implemented training program. Therefore, the findings were evaluated not as a direct causal effect of the program, but as an improvement observed after the training process. Significant improvements were observed in the dimensions of metacognition, flexibility, systematicity, and open-mindedness. However, no significant improvement was observed in perseverance-patience, which may reflect that certain dispositions require sustained practice and reinforcement (Demirbağ et al., 2016; Duckworth et al., 2007; Zimmerman, 2002). Studies examining the effects of various teaching

TABLE 8 Final interview findings related to the theme of teaching critical thinking.

Categories	Codes	f	Participants
Teachability	Being eligible for teaching	5	A,B,C,D,E
Roles of teachers	Delivering student-centered courses	9	A,B,C,D,E
	Tolerance	7	A,B,C,D,E
	Asking questions requiring in-depth responses	6	C,E
	Respectful	5	A,C
	Modeling critical thinking	5	A,B,C,D,E
	Asking for evidence of student ideas	1	D
Methods and techniques	Six thinking hats techniques	5	A,B,C,D,E
	Asking questions which require higher-order thinking	4	A,B,C,D
	Socratic technique/Socratic Circle/Questioning	4	A,C,D
	Idea development technique	2	A,E
	Group studies	2	D,C
	Aquarium technique	1	B
	Discussion	1	B
	Techniques improving thinking (compass phrase etc.)	1	D
	Barometer technique	1	E
Learning environment	Democratic	8	B,C,D,E
	Student-centered	7	A,B,E
	Supporting empathy	2	C
	Supporting open-mindedness	2	D,E
Assessment	Scale/test application	5	A,B,C,E
	Asking questions for higher order thinking	4	A,C,D,E
	Observation	4	A,B,D
	Text review	1	A
	Analysis of debates	1	B
Obstacles	Egocentrism	5	A,C,D
	Knowledge based education	5	B,C,E
	One-way thinking	3	B,E
	Being prejudiced	3	B,C,D
	Closed-mindedness	2	A
	Disliking making research	2	A
	Applying others' ideas without examining them	1	A
Perception of Competence	I consider myself as more sufficient	4	A,C,D,E
	I consider myself partially sufficient	1	B

Frequency (f) represents the total number of coded references to each category, not the number of participants; therefore, the same participant may contribute more than one coded reference to a category.

interventions on CT dispositions (Kestel, 2022; Kökdemir, 2003; McBride et al., 2002; Ömeroğlu and Hakkoymaz, 2025) have reported that structured CT training enhances pre-service teachers' dispositions towards CT.

Prior research has further demonstrated that practices designed to develop pre-service teachers' CT skills positively affect their dispositions (Aybek, 2006; Schreglmann, 2011; Uysal, 1998; Yang, 2005; Yang, 2012). For instance, Kong (2001) concluded that CT dispositions were positively strengthened following an experimental training program. Similarly, Vong and Kaewurai (2017) found that a teaching model aimed at enhancing their CT instruction improved pre-service teachers' CT dispositions. In the study by Kökdemir (2003), the CT training provided to undergraduate students in an introductory psychology course improved their CT dispositions. Similarly, Eğmir (2016), Tiruneh et al. (2014), and Williams (2005) suggest that teaching CT skills with a domain-independent approach is effective in helping students acquire these skills. The parallels between these studies and the findings of the current research are not limited solely to the observed increase in CT dispositions. As in the aforementioned studies, addressing CT through structured learning experiences and active participation can be considered a factor explaining the improved dispositions of participants to use CT skills. The significant increase in CT dispositions after training in quantitative findings, when considered together with qualitative findings, indicates a more comprehensive improvement. The fact that participants' explanations regarding CT became more detailed in the final interviews, and that they placed more emphasis on elements such as open-mindedness, considering and questioning different perspectives, can be considered as findings that complement the quantitatively observed increase in dispositions.

In addition to dispositions, participants' attitudes towards teaching CT were also examined. Participants' attitudes towards teaching CT were already positive at the pre-test stage, and improved significantly after the training. This improvement aligns with previous research indicating that targeted CT training fosters positive attitudes toward both the practice and value of teaching CT (Akdere, 2012; Gashan, 2015; Petek and Bedir, 2018; Yeh, 1997). The observed improvement suggests that pre-service teachers developed more positive attitudes towards integrating CT into their future teaching following the training. This finding is significant because it shows that even initially positive attitudes can be further improved after structured CT training. Furthermore, these findings contribute to the literature by providing evidence of changes in pre-service teachers' attitudes towards viewing CT not only as an individual thinking disposition but also in relation to their future teaching practices. The quantitative increase in attitudes toward CT teaching, considered alongside the more detailed explanations participants provided on how CT can be taught in recent interviews, indicates an improvement in their understanding and awareness of CT teaching after the training.

Prior the training, participants definitions of CT reflected only limited understanding, emphasizing the evaluation of positive and negative aspects and subject-matter knowledge. While these definitions captured some cognitive and affective aspects, but lacked essential components of CT (Bataineh and Alazzi, 2009; Choy and Cheah, 2009; Gashan, 2015; Kanik, 2010; Petek and Bedir, 2018; Semerci, 2010). Similarly, Palavan et al. (2015) found that teachers defined CT as distinguishing between appropriate and inappropriate ideas. In the same vein, prior the CT training implemented by Petek and Bedir (2018), pre-service teachers described CT as the ability to see both the good and bad sides of an issue. Petek and Bedir (2018) stated that pre-service teachers initially expressed CT characteristics based on intuition, reflecting a lack of a precise understanding and a narrow perspective (Wagley, 2013).

After the training, pre-service teachers were able to define CT using specific concepts- such as mental skills, affective traits, assumptions, claims, evidence, analysis, evaluation, and open-mindedness- rather than general terms (Buran, 2016; Evren, 2012; Halpern, 2014). Nugent (1990), in his study on five prerequisites for teaching CT, argued that teachers must first possess sufficient knowledge to define CT accurately. Similarly, Kuhn (1999) emphasized that CT becomes a meaningful educational goal only when its nature there is a clearly understood. Kanik (2010) also highlighted that teachers who accurately conceptualize CT and are familiar with teaching strategies can more effectivelty foster thinking skills in their students.

Based on both quantitative and qualitative findings, participants demonstrated positive changes in their dispositions and in their understanding of CT and its teaching following the training.

Participants' views on the teachability of CT remained consistent, recognizing the importance of teacher behaviours such as being tolerant (Baysal et al., 2017), being respectful (Nugent, 1990), and evidence-based reasoning. The training improved the participants' awareness of teachers' roles in fostering CT. Costa (1991) and Hemming (2000) emphasized that teachers who aim to develop CT skills among their students should first model these behaviors in classrooms and schools (Kanik, 2010; Snyder and Snyder, 2008). After the training, they articulated appropriate methods and techniques that promote CT through active and collaborative learning approaches (Halpern, 2014).

In addition, participants mentioned techniques such as asking questions that require higher-level thinking, the Six Thinking Hats, Barometer, Aquarium, and Socratic approaches. These findings align with previous studies reporting that techniques such as discussion (Dolapcı, 2009; Lipman, 1988), collaborative learning (Mahammoda and Şahin, 2019), Six Thinking Hats (AlJaafi and Sahin, 2019; Yılmaz, 2019), developing opinions (Bektaş et al., 2012), considering different perspectives (Bulut et al., 2009), fostering empathy (Palavan et al., 2015), and asking questions to stimulate higher-level thinking (Browne and Freeman, 2000; Browne and Keeley, 2007; Semerci, 2010) are effective in teaching CT.

It has been emphasized that in-class questions should be open-ended rather than short-answer (Güneş, 2012), as thought-provoking questions engage both CT and effective questioning skills (Shim and Walzack, 2012), thereby promoting higher-order thinking (Alkın, 2012). Following the training, participants described a student-centered learning environment that fostered democracy, empathy, and open-mindedness. Various studies have stated the importance of cultivating vlaues such as open-mindedness and empathy (McGuiness, 1999), and of creating

classroom environments that are democratic, respectful of differences, and tolerant (Kanik, 2010). After the training, participants demonstrated greater knowledge of alternative assessment methods, including observation, text analysis, and standardized tests. Previous research has shown that multiple-choice tests alone are insufficient for evaluating CT (Ennis, 1993; Halpern, 2003, as cited in Ku, 2009) and that relying on a single assessment method is inadequate (McMillan, 1987). Consequently, it is recommended to use both qualitative and quantitative approaches when assessing CT.

Akinoglu and Karsantik (2016) emphasized the importance of educators' awareness of obstacles to CT. During the pre-training period, pre-service teachers identified external barriers to CT, such as upbringing environment, social pressure, fear of ridicule, and teacher inadequacy. In addition, participants highlighted internal factors, including egocentrism arising from one's own mental processes (Nosich, 2018), one-sided thinking, prejudice (Demircioğlu, 2018), closed-mindedness, a dislike of research (Cottrell, 2005), and uncritically adopting others' ideas (Polat, 2015). Tendency to attribute obstacles primarily to external factors before the training may reflect their limited familiarity with CT and its pedagogy.

After the training, pre-service teachers reported feeling more competent in teaching CT. Nevertheless, both members of teacher training programs (Al-Degether, 2009; Demir, 2015; Gregory, 2011; Gültekin, 2016; Suleiman, 2012) and teachers (Alkın, 2012; Aslan, 2015; Baysal et al., 2017; Dinçer Göbel, 2013; Kanik, 2010; Piedade et al., 2020; Stephen, 2011) are inadequate in implementing CT in classroom activities. Pre-service teachers also reported feeling insufficient, particularly in applying CT strategies (Yeşilpınar and Doğanay, 2014), often due to a lack of theoretical knowledge (Gashan, 2015; Wagley, 2013), practical experience, and the skills required to integrate CT into instruction (Hashim, 2003).

Yang (2012) found that CT training during the pre-service period contributed to both the professional and personal development of student teachers, enabling them to reflect these gains in their course designs. Several studies have emphasized that both in-service and pre-service teachers require training on how to teach CT (Aycicek, 2021; Choy and Cheach, 2009; Petek and Bedir, 2018; Yang, 2012). Having sufficient training is essential for educators implementing CT-focused education (El Soufi and See, 2019). Taken together, the findings indicate that, following the training, participants demonstrated more developed understanding and awareness of CT teaching alongside more positive attitudes towards teaching CT.

5 Conclusions and implications

This study aimed to examine changes in pre-service teachers' CT dispositions, attitudes, and views toward teaching CT following CT training. The quantitative findings showed significant improvements in CT dispositions and attitudes toward teaching CT, particularly in metacognition, flexibility, systematicity, and open-mindedness, while qualitative findings revealed that at the end of the intervention, CT was understood more accurately conceptually, and participants became more willing to teach CT.

After the training, participants described the cognitive processes and affective dispositions associated with CT in ways that were more consistent with the literature. Their definitions shifted from general explanations toward more CT-specific concepts emphasizing evaluation, evidence-based reasoning, justification, comparison, and reflective judgment. They also demonstrated greater awareness of the teacher's role in fostering CT.

Following the training, participants demonstrated greater awareness of strategies, methods, and assessment approaches for teaching CT and provided more detailed explanations of how CT could be incorporated into classroom practice. These qualitative findings indicate a broader understanding of CT pedagogy following the training.

Overall, the findings suggest that structured and theory-based CT training may contribute to the development of pre-service teachers' CT dispositions, attitudes towards teaching CT, and their understanding and awareness of CT teaching.

These results have several important implications for teacher education programs and classroom practices. Considering positive perceptions of participants regarding both the learning-teaching process and their professional-personal gains, CT training may be offered as either a compulsory or an elective course within teacher education programs.

CT courses may be structured as two consecutive courses: one theoretical and one practice-oriented. In the applied course, pre-service teachers could design, implement, and evaluate lesson plans aimed at fostering CT. To support the development of dispositions such as perseverance and patience, providing pre-service teachers with long-term problem-based tasks, reflective journals, and continuous feedback may facilitate the sustained internalization of these dispositions.

Future research may extend CT training to different departments, grade levels, and student teachers groups. In senior-level teaching practicum courses, the extent to which student teachers integarate CT into lesson planning and classroom implementation may be examined. Longitudinal follow-up studies could also investigate the impact of CT training on teaching practices.

6 Limitations

This study has several limitations that should be taken into account when interpreting the findings. First, since the study is limited to pre-service teachers from a single university, the results may not be transferable to other institutional contexts. Another limitation is the relatively small sample size ($n = 28$), which may limit the generalizability of the results.

Second, this study employed a single-group pre–post design without a comparison group. Therefore, alternative explanations for the observed changes, such as external influences, cannot be entirely ruled out.

The absence of a control group in the study limits the direct attribution of the observed improvement in critical thinking tendencies to the implemented training program. Since the participants received a structured course on critical thinking for the first time, it is not possible to determine within the scope of

this study whether a similar improvement would occur as a result of a differently structured critical thinking course.

Furthermore, the CT training applied in the study was conducted over a limited period. Longer-term or longitudinal implementations may yield different effects on participants' CT dispositions and instructional competence. Finally, data collection relied on scales and interviews based on participants' self-reports, which may be subject to bias and participants' subjective perceptions. Future studies may benefit from incorporating different data collection tools and comparison groups to strengthen methodological rigor.

Data availability statement

The anonymized data supporting the conclusions of this article will be made available by the authors upon reasonable request, subject to ethical and confidentiality considerations.

Ethics statement

The studies involving humans were approved by Akdeniz University, Social and Human Sciences Social and Scientific Research and Publication Ethics Committee. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

İÖ: Conceptualization, Methodology, Investigation, Formal analysis, Data curation, Writing – original draft, Writing – review & editing. YE: Conceptualization, Methodology, Formal analysis, Supervision, Writing – original draft, Writing – review & editing.

Funding

The author(s) declared that financial support was not received for this work and/or its publication.

Acknowledgments

This article is based on the Ph.D. dissertation of İpek Önal, completed in 2020 under the supervision of Prof. Dr. Yavuz Erişen.

Conflict of interest

The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declared that generative AI was not used in the creation of this manuscript.

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