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Unveiling competence in the classroom: A multidimensional assessment of computer science teachers' self-efficacy in coding education

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Abstract
The significance of teachers' self-efficacy in coding education within K-12 settings has grown substantially. However, the literature lacks subject-specific measurement tools tailored to assess teachers' self-efficacy in coding instruction. This study adopted a mixed methods approach to develop a reliable and valid instrument for measuring computer science (CS) teachers' self-efficacy in teaching coding. The scale development involved a rigorous process encompassing item generation, expert validation, and pilot testing. Importantly, this process unfolded in seven steps with two distinct phases, and each phase involved independent sample groups. Subsequently, a comprehensive survey was administered to two samples of CS teachers ($n=318$, $n=295$) to assess the scale's psychometric properties. The results revealed robust internal consistency and construct validity of the 20-item Coding Teaching Self-Efficacy Scale (CTSES) with four intercorrelated dimensions: student motivation, subject knowledge, classroom management, and material development. Furthermore, additional analyses revealed the significant impact of teaching experience and self-reported coding knowledge level on teachers' self-efficacy in teaching coding. The implications of this study hold significance for both practitioners and researchers to understand teachers' self-efficacy in teaching coding and to explore its relation to teacher training, curriculum development, and the broader advancement of coding education within school settings.

Keywords Coding teaching self-efficacy scale (CTSES) · Computer science education · Self-efficacy assessment · Coding instruction · Scale development · Teacher self-efficacy

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1 Introduction

Self-efficacy, a foundational psychological concept developed by the esteemed psychologist Albert Bandura, encapsulates an individual's belief in their ability to successfully accomplish tasks, achieve goals, and cope with challenges in specific areas of life (Bandura, 1997). This concept has various applications and implications in different domains of life due to shaping individuals' behaviors, motivation, and overall sense of well-being (Schunk, 1995; Wang et al., 2015).

In the realm of education, the self-efficacy of teachers—commonly referred to as TSE (Teacher's Self-Efficacy)—assumes a pivotal role due to its profound impact on the efficacy of teaching practices (Boulden et al., 2021) and student's learning outcomes (Thoonen et al., 2011). TSE represents a teacher's belief or confidence in their ability to perform their teaching responsibilities effectively, create learning-supportive environments, and positively impact student learning outcomes (Bandura, 1993). Consequently, there has been a notable increase in scholarly attention towards TSE and its assessment in various educational contexts, owing to its substantial influence on instructional practices and student achievements.

In this educational landscape, computer science (CS) teachers—particularly those imparting coding knowledge—hold special significance (Zhou et al., 2020). Coding, which has emerged as a core curriculum subject, is being taught by CS teachers and is gaining widespread global recognition, including in countries like Turkey (Demirer & Sak, 2016). Often labeled as the "new literacy" (Jacob & Warschauer, 2018), coding is associated with essential cognitive skills deemed vital for succeeding in the modern world (Wing, 2006). Therefore, the evaluation of CS teachers' self-efficacy in teaching coding has taken on a pivotal role in nurturing their professional advancement, enhancing the achievements of their students, and enriching the overall quality of coding education. However, reliable psychometric instruments for gauging this aspect remain conspicuously limited.

The principal goal of this study is to develop and validate a comprehensive scale for measuring the self-efficacy of CS teachers, specifically in the context of teaching coding. This research endeavor aims to create a robust measurement tool that precisely captures the intricate nuances of teachers' confidence and competence in delivering coding instruction. By embarking on this undertaking, the study aims to provide an invaluable resource for evaluating and enhancing the capabilities of CS teachers, thereby potentially leading to the refinement of teaching methodologies, heightened academic performance among students, and an elevated standard of coding education.

It is worth highlighting that the terminologies associated with CS instruction, including coding, programming, and computational thinking (CT), can occasionally lead to confusion within academic literature. To mitigate this potential issue, a deliberate choice has been made to prefer the term "coding" over the broader designation of "(computer) programming." This shift in terminology stems from a desire for precision, as "coding" more comprehensively captures the essence and significance of the ongoing research. The motivation here is to ensure that the chosen language aligns closely with the intricate nuances of the subject matter, facilitating a more precise and profound understanding of the research in question.

2 Teachers' self-efficacy

For several decades, researchers have carefully explored the intricate dimensions of self-efficacy (Zee & Koomen, 2016), emphasizing its impact on the dynamics of teaching and learning processes. This emphasis stems from its far-reaching implications for education, as teachers' self-efficacy profoundly impacts their commitment, effort, and motivation in the classroom (Bandura, 1977). Furthermore, it is considered that teacher behaviors reflect their sense of efficacy (Tschannen-Moran & Hoy, 2001).

TSE is significantly associated with various substantial educational outcomes, spanning teacher and student-specific dimensions (Zee & Koomen, 2016). Prior research has indicated that teachers with high self-efficacy are more prone to exhibit heightened resilience within the classroom setting, experience greater job satisfaction, and report lower incidences of burnout (Dicke et al., 2014; Wang et al., 2015). Increased TSE has also been linked to utilizing diverse instructional strategies, heightened commitments to professional obligations, cultivating positive emotions, and reducing anger and frustration within the classroom environment (Burić & Macuka, 2018). Moreover, research shows that TSE positively correlates with motivational levels (Calkins et al., 2023).

Researchers have identified several factors influencing TSE: experience, education and interest, subject knowledge, preparation (Nordlöf et al., 2019), teaching experience, and teaching context (Wray et al., 2022). There is also substantial evidence suggesting that TSE significantly impacts teachers' instructional quality (Burić & Kim, 2020) and student learning outcomes (Guo et al., 2012; Shahzad & Naureen, 2017). According to Bandura (1997), the accumulation of teaching experience plays a pivotal role in shaping a teacher's perception of efficacy. Bandura (1997) referred to this as "mastery experiences," asserting that as teachers accumulate mastery experiences in the classroom, their sense of efficacy naturally increases.

3 Coding education

Coding, a cornerstone in CS, involves crafting instructions using programming languages to guide computers in executing tasks. This practice translates human-conceived algorithms into functional applications, driving innovation and problem-solving (Romero et al., 2017; Tuomi et al., 2018). By bridging human intent and machine execution, coding shapes modern technology and stands as a testament to human ingenuity.

This revolutionary potential of coding for education has long been acknowledged, offering the capacity to reshape learning paradigms (Papert, 1980). Coding is recognized as a vital twenty-first-century skill intertwined with CT as an essential domain (Wing, 2006). This recognition is underscored by a meta-analysis emphasizing coding as the most effective tool for nurturing CT proficiencies in K-12 education (Merino-Armero et al., 2022).

As described by Lye and Koh (2014), coding extends beyond constructing code segments; it embodies a broader process that introduces students to CT, enabling problem-solving through CS principles like abstraction, debugging, remixing, and iteration. Enhancing K-12 students' grasp of coding is an intricate endeavor that necessitates profound institutional shifts, proactive engagement from educators, and the development of substantial educational resources (Barr & Stephenson, 2011). This multifaceted strategy reflects the realization that coding goes beyond technical skill, serving as a gateway to CT in a dynamic digital landscape.

Recognizing the profound role of coding in the digital landscape, teaching students how to code has become crucial for CS teachers in K-12 classrooms. Equipping students with coding skills has evolved into an essential endeavor, catering to intrinsically indispensable proficiencies in the digital age. Several European nations have integrated coding into their educational curricula, marking a significant step in educational methodologies (Balanskat & Engelhardt, 2015; Vegas et al., 2021).

4 Teachers' efficacy of teaching coding

Understanding teachers' beliefs about teaching coding has many benefits, including improving effective instruction, engaging students, addressing challenges, supporting professional development, and informing curriculum design and policy-making. According to Bandura (2006), self-efficacy beliefs influence "the courses of action people choose to pursue, the challenges and goals they set for themselves, and their commitment to them, how much effort they put forth in given endeavors, the outcomes they expect their efforts to produce, how long they persevere in the face of obstacles, [and] their resilience to adversity" (p. 309). In addition, it has been long noted that a teacher's belief about a subject affects their teaching practices (Fang, 1996). In essence, teachers' self-efficacy beliefs significantly impact their commitment to and dedication to a subject.

However, it is essential to differentiate teachers' belief in their ability to teach coding from their belief in its importance. While the former pertains to self-efficacy beliefs, the latter relates to the value assigned. Bandura (2010) explicitly outlined that self-efficacy is tied to one's perceived competence rather than actual competency levels. In contrast, as Tschannen-Moran and Hoy (2001) explained, a teacher's self-efficacy in teaching encompasses their judgment of their capabilities to achieve desired student engagement and learning outcomes. In other words, teachers' teaching efficacy includes perceiving their ability to carry out a task and anticipating specific results.

CS education, especially coding and programming, has been expanding globally, with high-income countries offering more CS education than low-income nations (Vegas et al., 2021). Typically given by CS teachers, coding education is now also being entrusted to educators without a CS background, including classroom teachers, due to the increasing demand (Yadav et al., 2016). Many of these teachers, however, need more formal training in coding. Some studies have implemented professional development (PD) training to enhance teachers' efficacy in teaching coding (Rich et al., 2021a, b; Zhou et al., 2020). The outcomes of these studies demonstrate significant improvements in teachers' self-efficacy for coding following the completion of PD programs.

5 Teacher self-efficacy scales

There are several teacher self-efficacy scales that vary not only in their focus and scope but also in the specific aspects of teacher efficacy they assess. The scale developed by Tschannen-Moran and Hoy (2001) is a widely employed instrument for measuring general classroom teaching self-efficacy. It has three efficacy dimensions: classroom management, instructional strategies, and student engagement. Although it is useful to assess teacher efficacy in a broad sense, it may not capture the nuances of specific teaching contexts or subjects like coding teaching. According to Bandura (2012), to accurately measure self-efficacy, it is necessary to consider the specific domains, tasks, and contextual factors that shape individuals' confidence and competence. Accordingly, context-specific self-efficacy scales, like the scale designed in this study, are a critical consideration in understanding and assessing individuals' beliefs in their abilities across different domains and tasks (Bandura, 1977).

There are also scales that are partly relevant to coding education, but they are either developed for university students (Korkmaz et al., 2017) or used for a sample of non-computer sciences teachers (Rich et al., 2021a; Zhou et al., 2020). However, the participants in this study are exclusively in-service CS teachers who possess degrees in CS, constituting a highly specialized and relevant cohort. More importantly, while the previous scales mentioned assess teachers' knowledge and skills related to CT and coding, the scale developed in this study aims to gauge in-service CS teachers' confidence and belief in their ability to effectively teach coding concepts and skills to their students. In essence, it assesses how confident in-service CS teachers are in their capacity to facilitate coding education in a classroom setting. This self-efficacy scale is designed to provide insights into teachers' perceptions of their teaching abilities in coding instruction, which is crucial for understanding their readiness and preparedness to deliver coding education effectively.

This study holds theoretical significance as it advances Bandura's social cognitive theory by examining teacher self-efficacy within the unique context of coding education, thereby extending our understanding of how cognitive, emotional, and motivational processes manifest in this specific domain. The research also contributes to the contextualization of self-efficacy, aligning with Bandura's guide for assessing self-efficacy in specific contexts. On a practical level, the study offers valuable insights for educators and institutions aiming to enhance teaching practices in coding education. It provides actionable information for curriculum design and instructional strategies, acknowledging the critical role of teacher self-efficacy in influencing student motivation, subject knowledge, classroom management, and material development.

6 Theoretical background

Teacher self-efficacy has its foundation in Bandura's social cognitive theory (Bandura, 1977, 1986, 1997), which asserts that it encompasses not only an educator's beliefs about their capacity to impact student learning, *personal efficacy,* but also the outcomes derived from particular instructional interventions, *outcome expectancy* (Tschannen-Moran et al., 1998). In theory, teacher self-efficacy is believed to influence educators' cognitive, emotional, and motivational processes, thereby shaping and directing their instructional behaviors in the classroom (Bandura, 1997). Tschannen-Moran et al. (1998) underscore the direct impact of self-efficacy on teachers' teaching practices and its indirect effects on student achievement and classroom attitudes. Building on Bandura's (2006) guide to assess self-efficacy in specific contexts, scholars have investigated varying facets of teacher self-efficacy concerning particular teaching and learning processes. The current research delineates four aspects of teacher self-efficacy within the specific context of teaching coding.

6.1 Student motivation

Students exhibit their motivation through active engagement in learning and academic activities (Connell & Wellborn, 1991). As proposed by self-determination theory, many factors could contribute to students' motivation in the classroom, such as social relatedness to others (Deci & Ryan, 1985). The pivotal role of teacher's self-efficacy in shaping various dimensions of students' educational experiences is evident, with student motivation being a crucial and undeniable component of this impact (Shin & Shim, 2021). Teacher self-efficacy is characterized as a motivational attribute that influences students' motivational beliefs (Schiefele & Schaffner, 2015). The broader literature suggests that students are more likely to be motivated when they perceive their teacher as confident and competent (Shin & Shim, 2021).

6.2 Subject knowledge

Subject knowledge is critical to teacher competency (Shulman, 1986). Enhancing teachers' subject knowledge can positively impactheir self-efficacy (Swackhamer et al., 2009). The relationship between teachers' subject knowledge and their self-efficacy is vital to their professional development (Zhou et al., 2020). The value of subject knowledge in teachers' self-efficacy is informed by social cognitive theory which proposes that self-efficacy is driven by four key sources of experiences: mastery experiences, vicarious experiences, physiological state, and social persuasion (Bandura, 1993; Klassen et al., 2011). Specifically, mastery experiences, which reflect a teacher's success in overcoming content-specific challenges, emerge as a crucial predictor for teachers' self-efficacy and demonstrate a significant association with the development of their self-efficacy (Tschannen-Moran & Hoy, 2007).

6.3 Classroom management

Successful classroom management strategies enhance a teacher's confidence in their ability to create a positive and effective learning environment (Jennings & Greenberg, 2009). In this respect, teachers' self-efficacy affects their ability to create goals, maintain perseverance, and exert effort in teaching situations (Bandura, 1997). Classroom management is considered an essential element when measuring teachers' self-efficacy within the the classroom (Tschannen-Moran & Hoy, 2001). Conceptually, it involves establishing and maintaining a sense of order and discipline within the classroom while effectively addressing disruptions that may arise during instructional time (Emmer & Stough, 2001).

Classroom structure and organization, recognized as pivotal components of effective classroom management, exhibit positive correlations with teachers' self-efficacy beliefs (Burić & Kim, 2020; Dicke et al., 2014). Moreover, teachers' self-efficacy for classroom management is integral to their professional skills (Kunter & Baumert, 2007) and emerges as a decisive factor influencing the efficacy of chosen classroom management strategies (Brouwers & Tomic, 1999; Dicke et al., 2014). Empirical evidence underscores the pivotal role of teachers' self-efficacy in the successful execution of classroom management strategies (Jia & Hermans, 2022) and suggest a positive relationship between teacher self-efficacy in classroom management and the actual classroom environment perceived by students (Hettinger et al., 2021). Consequently, classroom management has been acknowledged as a significant sub-dimension within the broader construct of teachers' self-efficacy.

6.4 Material development

Instructional materials encompass all forms of digital and non-digital materials CS teachers can use for teaching or learning activities. Materials development entails designing engaging and relevant content (Krajcik & Delen, 2017) that facilitates a deeper understanding of coding concepts. Developing instructional materials is a crucial aspect of teacher preparation, significantly shaped by teacher self-efficacy (Bray-Clark & Bates, 2003). Several initiatives have been undertaken to measure teachers' self-efficacy in material development (Balçın & Ergün, 2016), underscoring the importance of self-efficacy in designing and preparing instructional materials for the teaching-learning process. Research evidence shows that teachers with high self-efficacy tend to create diverse instructional materials as part of their intervention strategies (Allinder, 1994). Consequently, teacher self-efficacy can significantly shape the development of various instructional materials in coding education.

7 Method

7.1 Procedure and samples

This study was carried out in two main phases, each involving several specific steps. Figure 1 depicts an overview of the strategies and methodologies employed during each step. Furthermore, the convenience sampling method was used to select independent sample groups for each study step. Table 1 presents detailed information about the demographic characteristics of each group of participants.

Phase 1:

- Step 1: Determining the hypothesized factors
- Step 2: Generating the item pool
- Step 3: Including the items
- Step 4: Assessing the content adequacy
- Step 5: Pretesting

Phase 2:

- Step 6: Determining the factorial structure
- Step 7: Validating

7.2 Phase 1

This phase focused on establishing the structure of the scale and ensuring that the items were clear and understandable so that they could be applied to large sample groups. Specifically, the content and face validity of the scale were established in this phase through five steps.

Step 1: Determining the hypothesized factors

In this step of the research, a comprehensive literature review was carried out, with a specific emphasis on important concepts such as self-efficacy, measurement of self-efficacy, teacher self-efficacy, coding, coding education, and the development of measurement scales. As a follow-up to this review, detailed semi-structured independent interviews were conducted with a representative sample group of 15 CS teachers, consisting of 7 females and 8 males, all of whom had prior experience in teaching coding. These participants, ranging in age from 27 to 35 years with a mean age of 31.71, provided invaluable insights into the understanding of self-efficacy within the realm of coding education. A thorough description of the interview protocol form used in these interviews and the associated interview questions are detailed under the "*Interview Protocol Form*" section in this manuscript. The interviews, each with a duration of approximately 30 minutes, were transcribed verbatim to ensure a precise capture of the depth and nuances of the discussions. A systematic

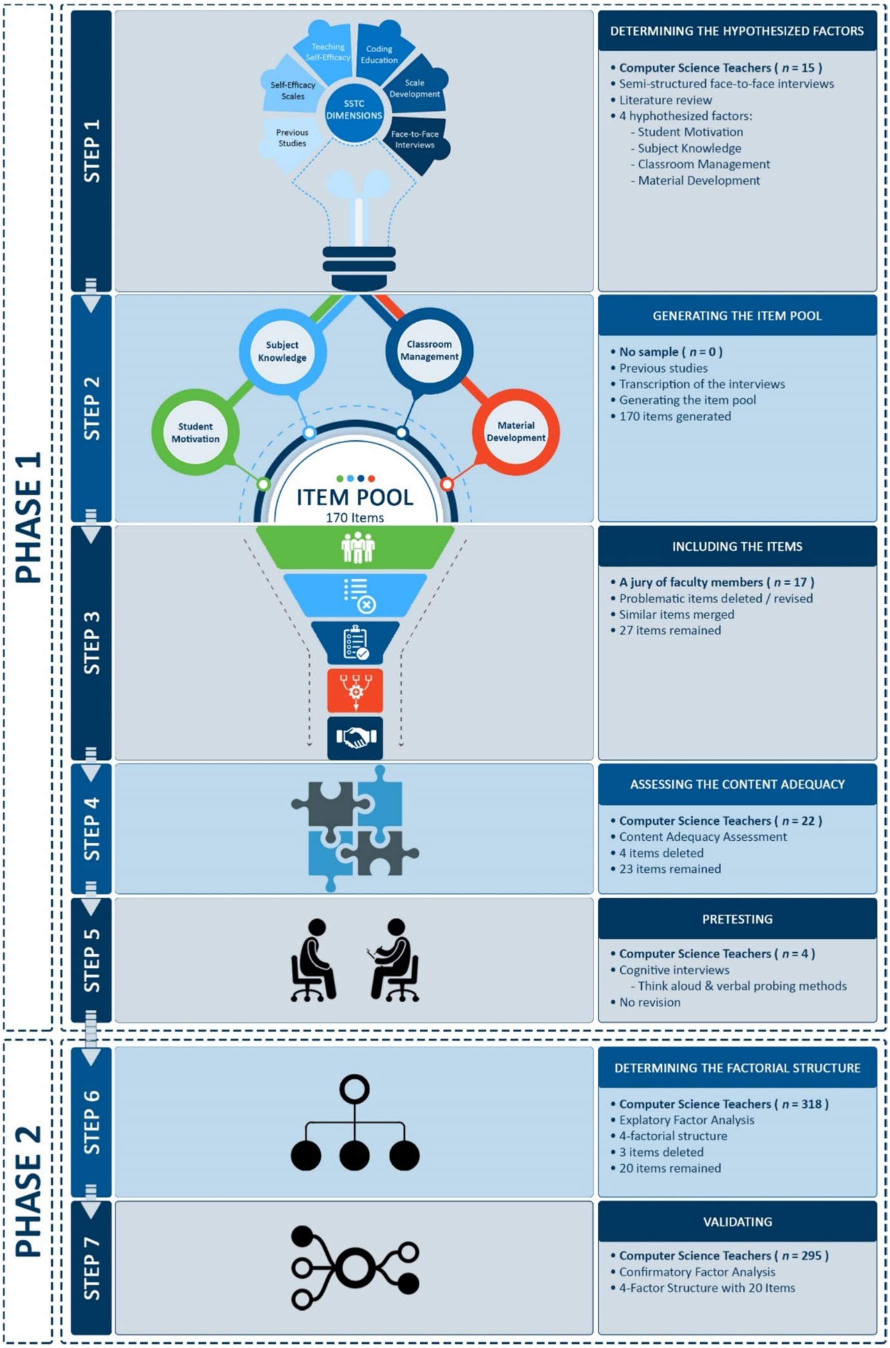

Fig. 1 Flow chart of the procedures followed during the development and validation of the CTSES

Table 1 Demographics of sample groups

			Education (*f*)			Age		Teaching / Domain Experience in Year	
		f	*BS*	*MS*	*PhD*	*M*	*SD*	*M*	*SD*
Phase 1									
Step 1 ($n=15$)	Female	7	5	2	–	31.71	2.29	7.85	3.24
	Male	8	7	1	–	31.63	3.20	8.50	3.21
	Total	15	12	3	–	31.67	2.72	8.20	3.12
Step 2 ($n=0$)	No sample								
Step 3 ($n=17$)	DCS	7	–	4	3	33.86	4.53	1.14	4.53
	DME	7	–	2	5	33.43	2.76	9.43	4.04
	DTLL	3	1	2	–	33.67	4.04	11.33	5.51
	Total	17	1	8	8	33.65	3.55	1.06	4.25
Step 4 ($n=22$)	Female	10	4	3	3	3.90	2.64	6.60	1.58
	Male	12	2	4	6	3.58	2.87	5.25	1.60
	Total	22	6	7	9	3.73	2.71	5.86	1.70
Step 5 ($n=4$)	Female	2	–	2	–	28.00	1.41	6.00	2.00
	Male	2	1	1	–	27.50	0.71	5.50	0.71
	Total	4	1	3	–	27.75	0.96	5.75	0.96
Phase 2									
Step 6 ($n=318$)	Female	151	138	12	1	28.95	4.44	5.25	4.67
	Male	167	151	12	4	3.59	5.47	6.60	5.92
	Total	318	289	24	5	29.81	5.07	5.96	5.40
Step 7 ($n=295$)	Female	159	148	11	–	28.13	5.29	4.94	4.92
	Male	136	126	8	2	3.87	6.26	6.34	5.28
	Total	295	274	19	2	29.39	5.91	5.59	5.13

**BS* Bachelor of Science, MS: Master of Science, *Ph.D.* Philosophy of Doctorate, *DCS* Department of Computer Science, *DME* Department of Measurement and Evaluation, *DTLL* Department of Turkish Language and Literacy

approach was utilized for coding the qualitative data obtained from these interviews. This process, which was guided by criteria based on the key subjects highlighted in the literature review, focused on aspects such as teaching methodologies, challenges in coding education, and the factors influencing teacher self-efficacy. Content analysis was independently conducted by each researcher, following to these predetermined criteria to ensure a thorough analysis of the data. Subsequently, a collaborative effort was made to compare and discuss any discrepancies, ultimately leading to a consensus on the structure of the codes and themes. Furthermore, the consistency of coding across the researchers was measured, resulting in a consistency coefficient of 0.87. This significant level of agreement amongst the researchers considerably strengthened the credibility of the findings. Consequently, this step laid the foundational groundwork for the development of a coding education framework and led to the identification of four hypothesized factors that are believed to influence self-efficacy in teaching coding.

Step 2: Generating the item pool

An inductive approach was utilized to produce a robust set of items. 170 items were generated and incorporated into the item pool to encompass the hypothesized factors. The development of these items followed established guidelines, as outlined by DeVellis (2012), to ensure that the item pool included a minimum of three to four times the number of potential items required for the final scale.

Step 3: Including the items

A panel of experts examined the quality of each item in the pool. The panel consisted of 17 faculty members, each with at least five years of experience. Seven were from the Department of Computer Science, seven from the Department of Measurement and Evaluation, and three from the Department of Turkish Language and Literature. Their ages ranged from 29 to 42 years, with a mean age of 33.65. During the examination process, the panel collaboratively discussed to improve the clarity, understandability, applicability, and comprehensiveness of the items. This included merging, revising, and, in some cases, removing certain items. For example, given the similarity between "I can help students develop positive attitudes towards coding" and "I can foster a positive mindset in students towards coding," a decision was made to remove one of them. The process demonstrated a strong consistency coefficient of .92 among the panel members, indicating a robust agreement in their evaluations. This step also aimed to create a scale with internally consistent items for a thorough assessment of teaching coding self-efficacy while keeping the scale's length as concise as possible to mitigate potential boredom and fatigue effects. Consequently, a consensual approach led to the inclusion of 27 items in the scale.

Step 4: Assessing the content adequacy

A thorough assessment of the 27 items was undertaken by 22 experienced CS teachers, all possessing a minimum of four years of professional experience. Their ages ranged from 27 to 32 years. To evaluate the scale's content validity, the researchers adhered to the 18-step guideline proposed by McKenzie et al. (1999). Following this guideline, a specific questionnaire was meticulously prepared, encompassing general information about the self-efficacy construct, detailed descriptions of each hypothesized factor, and the 27 items. In administering the questionnaire, teachers were tasked with matching each item, presented in mixed order, to the descriptions of the hypothesized factors based on their similarity. The analysis of the results revealed that more than 20% of the teachers matched four items to the wrong hypothesized factor. Consequently, these four items were omitted from the scale.

Step 5: Pretesting

In this step, cognitive interviews and think-aloud protocols were employed to assess respondents' comprehension of the 23 items about their meaning and clarity. Four CS teachers took part in these interviews, with an average age of 27.75 years. The outcomes of the interviews did not reveal any notable concerns or highlight problematic aspects related to the items.

7.3 Phase 2

In the second phase, the scale underwent an assessment of its factorial structure. This phase encompassed a series of analyses to investigate and validate the scale's structure to ensure its construct validity.

Step 6: Determining the factorial structure

Exploratory factor analysis (EFA) was used to determine the scale's factor structure. The data was derived from the online survey responses provided by the 350 CS teachers. After a thorough dataset screening, encompassing the handling of outliers, addressing missing values, and verifying assumptions of normality, 32 cases were excluded. The participants' ages ranged from 20 to 57, with a mean of 29.81 years. The result of the EFA revealed a 4-factorial structure and the decision was made to exclude three items due to cross-loading. Subsequently, the analysis proceeded with the remaining 20 items.

Step 7: Validating

Confirmatory factor analysis (CFA) was used to validate the 4-factorial structure of the 20-item scale. The data was collected through an online survey administered to 315 CS teachers. After a comprehensive examination of the data for outliers, missing values, and normality assumptions, 25 cases were removed. Participants ranged from 21 to 58 years, with an average age of 29.39 years. The final 4-factor scale, consisting of 20 items, was deemed valid and reliable for assessing teachers' self-efficacy in teaching coding.

7.4 Measures

7.4.1 Coding teaching self-efficacy scale (CTSES)

The Coding Teaching Self-Efficacy Scale (CTSES) consists of four dimensions: (1) student motivation, (2) subject knowledge, (3) classroom management, and (4) material development. Respondents used a 5-point Likert-type scale to rate their responses, with options ranging from "never" to "always" (1-never, 2-rarely, 3-sometimes, 4-often, and 5-always).

7.4.2 Demographic information form

The demographic form consists of two main sections with six questions. The first section collects information about gender, age, education level, and teaching experience in years. The second section focuses on participants' coding knowledge. Additionally, an open-ended question invites participants to share their suggestions on the competencies a CS teacher should possess for more effective and efficient coding instruction. This form was consistently employed in all steps involving CS participants, with slight adjustments to accommodate each respective step's unique circumstances.

7.4.3 Interview protocol form

The interview protocol form, included in Appendix Table 5, is constructed with the theoretical foundation rooted in Bandura's social cognitive theory (1986), emphasizing the assessment of self-efficacy levels crucial for effective coding instruction among CS teachers. The form is divided into five main sections and includes semi-structured questions specifically designed to evaluate the self-efficacy levels needed by CS teachers for effective coding instruction. These questions are intended to gather comprehensive data by exploring participants' approaches to conducting coding lessons and their strategies for addressing instructional challenges. The form was utilized in the first phase of the study, beginning with a clear statement of the study's purpose, providing context for the interviewees. It then outlines the interview details, including the interviewer's demographics, date, duration, and location, ensuring a structured approach to the interview process. This is followed by a section on informed consent, emphasizing the study's adherence to ethical guidelines and participant rights. The core of the form comprises seven meticulously crafted interview questions, such as "*How confident do you feel about your ability to teach coding effectively? Can you share any specific experiences that have influenced this perception?*" and " *How do you integrate various resources and tools into your coding curriculum? What role do this play in shaping your teaching methods and self-efficacy in delivering coding education?*" These questions are designed to elicit in-depth responses on personal perceptions, teaching methodologies, challenges, and competencies related to teaching coding. Each question aims to explore different facets of the teacher's experiences and views, providing a holistic understanding of their self-efficacy in coding education.

7.4.4 Content adequacy assessment questionnaire

The content adequacy assessment questionnaire evaluates self-efficacy content in two parts. Grounded in Bandura' (1986) social cognitive theory, it forms a theoretical foundation for understanding self-efficacy. Developed following DeVellis' (2003) guidelines, the questionnaire's first section offers detailed descriptions of hypothesized factors, reflecting the multifaceted nature of self-efficacy. In the second section, participants match 27 items given in randomized orders with the factors based on provided descriptions, ensuring a comprehensive evaluation of content alignment with the theoretical framework. This questionnaire was used in the fourth step of the study.

7.5 Translation of the scale

The CTSES was developed in the Turkish language. After completing the analyses and confirming the validity and reliability of the scale, a rigorous translation process was undertaken to ensure the accuracy and fidelity of the English version of the scale. The scale items were first translated from Turkish into English by the researchers. Two bilingual academics from the university's Academic Writing Centre carefully reviewed each translated item to improve the accuracy and linguistic quality of the translations. Their comprehensive assessment included meaning, accuracy, wording, spelling, and grammar. Their insightful comments served as the basis for necessary revisions. Two additional academics, with expertise in Turkish and English and a deep understanding of coding pedagogy, conducted a rigorous review of each scale item. In response to the valuable feedback from the experts, two specific items within the scale were carefully revised to ensure that they accurately conveyed the intended meaning. In addition, during the translation and revision phase, the research team used the British National Corpus to assess the frequency of each word used within the scale items. The final version of the scale items in both Turkish and English can be found in the Appendix Table 6.

7.6 Data analysis methods

This mixed-methods study involved both qualitative and quantitative data collection and analysis. Qualitative data were analyzed using the constant comparative method, while descriptive and inferential statistics were applied to the quantitative data. MAXQDA 2022 and IBM SPSS 28 were used for qualitative and quantitative data analysis.

8 Results

8.1 Factor discovery analysis with EFA

The following procedures were conducted to examine the underlying structure of CTSES. First, to determine the factor extraction method, a multivariate normality test was applied using Mardia's Test with the help of a particular syntax file by (Hayton et al., 2004). The test produced a non-significant result, showing that the multivariate assumption is violated. Therefore, principal axis factoring was selected as a factor extraction method (Fabrigar et al., 1999; Taylor & Pastor, 2007). Second, the Kaiser-Meyere-Olkin Measure of Sampling Adequacy (KMO) value was

0.96, exceeding the suggested threshold of 0.60, and Bartlett's Test of Sphericity was significant (BTS value = 5493.792, $p < .05$), confirming that the quantitative data is appropriate for factor analysis (Tabachnick & Fidell, 2013). Third, as for the rotation method, Oblimin with Kaiser Normalization was selected because the variables were correlated and normally distributed (Costello & Osborne, 2005). Fourth, the factor structure of CTSES was designated as having four factors. Therefore, EFA was conducted with 23 items to extract four factors. The result revealed three problematic items due to cross or low loadings. Finally, after dropping those items, a second EFA was conducted with 20 items, resulting in a reliable four-factor model with a cumulative variance of 73.53%. The description of the retained factors is as follows:

Student Motivation (SM) (6 items): This factor refers to the CS teacher's teaching coding abilities to instill creative thinking and motivation towards coding, drive their interest, and develop a positive attitude to coding.

Subject Knowledge (SK) (6 items): This factor refers to the CS teacher's knowledge of explaining basic code concepts, writing and debugging a code for solving a problem, and creating a coding algorithm to determine its outcome.

Classroom Management (CM) (4 items): This factor refers to the CS teacher's abilities to manage and create appropriate behavior for students during coding activities by encouraging them to follow the classroom rules, ensure class safety, and deal with negative student behaviors.

Material Development (MD) (4 items): This factor refers to the CS teacher's abilities to conduct coding activities in different programming environments, prepare appropriate instructional materials for coding activities, and produce proper assessment tools to measure coding skills.

8.2 Factor verification analysis with CFA

CFA was conducted with IBM AMOS 28 statistical software to check the factor variability of the four-factor model using the data from 295 participants. The maximum likelihood (ML) method was used to estimate the model parameters, predicting the extent to which the data fit the hypothesized model. The cut-off values considered to assess model fit included Chi-square/df (CMIN/df), the Comparative Fit Index (CFI), the Tucker-Lewis Index (TLI), the Root Mean Square Error of Approximation (RMSEA), and the Standardized Root Mean Square Residual (SRMR) (Bentler, 1990; Kline, 2016). According to the threshold values suggested by prominent authors, CFI and TLI > 0.90 represent a good fit (Hu & Bentler, 1999; Kline, 1998), RMSEA <0.08 and < 0.06 indicate a fair fit (Browne & Cudeck, 1993), and SRMR <0.08 shows a good fit of the model (Hu & Bentler, 1999). The CFA analysis in this study produced a significant result for chi-square, 0.914 for CFI, 0.901 for TLI, 0.076 for RMSEA, and 0.067 for SRMR. Chi-square statistics is criticized due to being conservative in detecting minimal differences. Therefore, it is prone to be significant in a large sample size (Bollen, 1989; Kline, 1998). As a result, with all the reported indexes considered, the four-factor structure model fits well for the sample size.

Furthermore, the CFA result showed that each factor item significantly contributed to the factor to which it belonged, with a loading larger than 0.59. In addition, except for the loadings of five items between 0.59 and 0.69, the other items had loadings higher than 0.70. Since there were no specification errors, further alterations (modification indices) were unnecessary. We also computed the average variance extracted (AVE) estimates for each factor, which evaluate the variance captured by the construct relative to the amount of variance due to measurement error. Figure 2 visually presents the dimensions for a clearer understanding of the CTSES's underlying structure. Table 2 also provides a detailed summary of items along with their corresponding contents, factor loadings, and descriptive statistics for the final CTSES, offering a comprehensive view of the scale's psychometric properties.

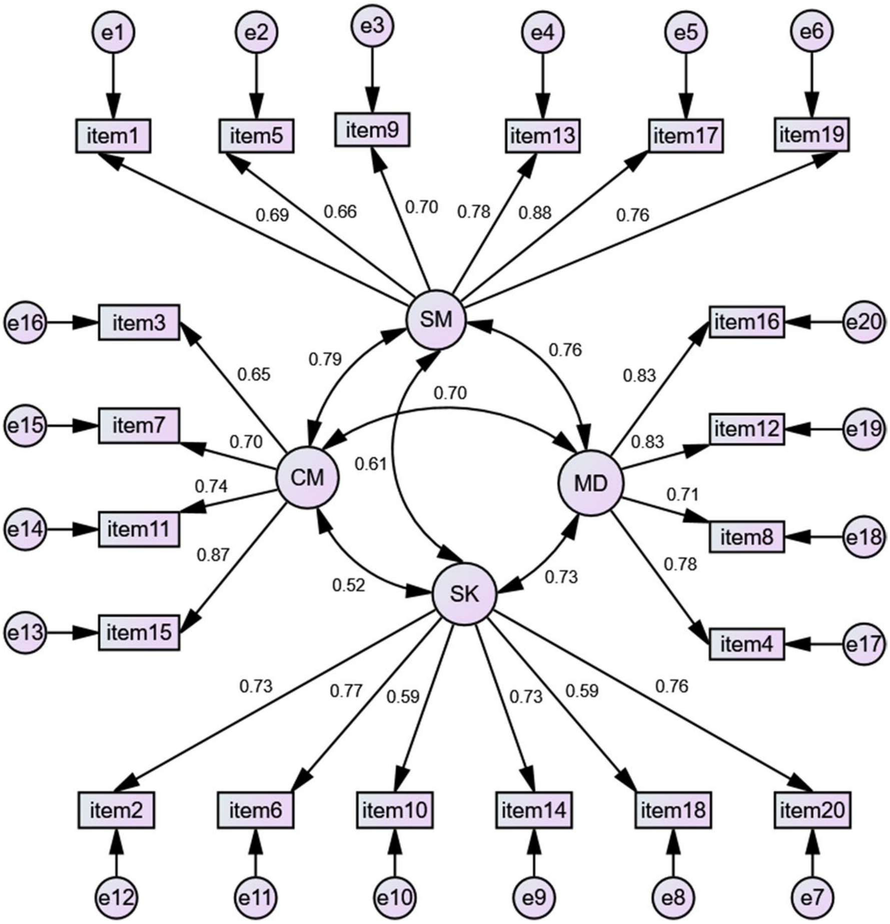

Fig. 2 Standardized coefficients for the four-factor model of CTSES

Table 2 Items, factor loadings, and descriptive statistics for the final CTSES

Dimensions	Items "I can …"	Factor loadings	*M*	*SD*
Student Motivation	(α =0.88 CR =0.88 AVE =0.56)			
Item17	... increase students' interest in coding.	0.88	4.10	0.69
Item13	... convince students that they can be successful in coding.	0.78	4.00	0.72
Item19	... arouse students' curiosity about coding.	0.76	4.12	0.66
Item9	... support students in creative thinking during the coding teaching process.	0.70	4.09	0.66
Item1	... help students develop positive attitudes towards coding.	0.69	4.21	0.75
Item5	... increase the motivation of students who are reluctant to code.	0.66	3.84	0.83
Subject Knowledge	(α =0.84 CR =0.85 AVE =0.49)			
Item6	... determine the outcome of a program whose algorithm is given.	0.77	4.24	0.75
Item20	... debug a piece of code.	0.76	3.90	0.83
Item2	... create the right algorithm for solving a problem.	0.73	4.23	0.76
Item14	... explain basic coding concepts such as data, operator, comparison, and loop.	0.73	4.28	0.72
Item18	... write code for solving a problem in any programming language.	0.59	3.43	0.94
Item10	... keep my coding knowledge up to date.	0.59	3.96	0.78
Classroom Management	(α =0.83 CR =0.83 AVE =0.55)			
Item15	... provide classroom management during coding activities.	0.87	4.08	0.69
Item11	... ensure class safety during coding activities.	0.74	4.16	0.61
Item7	... deal with negative student behaviors that may occur during coding activities.	0.70	3.91	0.73
Item3	... ensure that students follow the classroom rules during coding activities.	0.65	4.15	0.68
Material Development	(α =0.87 CR =0.87 AVE =0.62)			
Item12	... organize coding activities suitable for the student level.	0.83	4.04	0.74
Item16	... prepare instructional materials suitable for coding activities.	0.83	3.93	0.77
Item4	... prepare teaching materials suitable for the level of the student.	0.78	4.00	0.73
Item8	... develop appropriate assessment tools to measure coding skills.	0.71	3.92	0.72

α Cronbach's alpha, *CR* Construct Reliability, *AVE* Average Variance Extracted. $N=295$

8.3 Construct reliability and validity

The four-factor model fits well as CFI and TLI are larger than 0.90, and RMSEA and SRMR are below 0.08 (Hu & Bentler, 1999). As shown in Table 2, all factor loadings were significant and ranged between 0.59 and 0.88 ($M = 0.73$), demonstrating convergent validity. The Cronbach alphas show satisfactory reliability with alpha coefficients of 0.88 for the 6-item SM, 0.84 for the 6-item SK, 0.83 for the 4-item CM, and 0.87 for the 4-item MD. Additionally, each factor item was inspected with item-total correlations. The analysis culminated with Cronbach's alpha ranging from 0.72 to 0.87, showing that the items in each factor had sufficient internal consistency (Nunnally, 1970). Construct reliabilities also indicate satisfactory internal consistency for four factors by exceeding 0.83. Besides, AVE estimates exceed the minimum level of 0.50 for each factor (Fornell & Larcker, 1981). Consequently, all these estimates demonstrate good construct reliability and validity for CTSES.

8.4 Further validation

Convergent validity was tested by analyzing the strength of the relationship between the scores from each CTSES subscale. The result shows that all subscales exhibited strong and positive correlations at a significant level of $p < .001$. Besides, no multicollinearity (high-shared variance) was detected, meaning that factor coefficients were not greater than 0.90 (see Fig. 2). Table 3 also summarizes the descriptive statistics and correlations among the CTSES dimensions.

Multivariate analysis of variance (MANOVA) was conducted to examine the effect of gender, age, and coding knowledge on the four dimensions of the CTSES. Main effects produced a statistically significant difference in only coding knowledge (F (8, 530) = 5.90, $p < .05$; Wilk's $\Lambda = 0.843$, $\eta^2 = 0.08$) on the combined dependent variables. The univariate main effects, which were derived from follow-up tests, indicated a significant effect of coding knowledge on the SK, F (2, 268) = 15.306, $p < .05$, $\eta^2 = 0.103$, and the MD, F (2, 268) = 2.957, $p < .05$, $\eta^2 = 0.022$. Teachers with advanced coding knowledge had higher efficacy for subject knowledge than those with intermediate coding knowledge. In addition, teachers with intermediate coding knowledge had higher efficacy for subject knowledge and material development than those with beginner coding knowledge.

Table 3 Means, standard deviations, and correlations of the scale factors

Factor	*n*	*M*	*SD*	1	2	3	4
1. Student Motivation	295	4.06	0.72	–			
2. Subject Knowledge	295	4.01	0.80	0.56*	–		
3. Classroom Management	295	4.08	0.68	0.60*	0.37*	–	
4. Material Development	295	3.97	0.74	−0.75*	−0.76*	−0.56*	–

*$p < .001$. Mean entries of scale dimensions are based on a 5-point scale

Analysis of variance (ANOVA) was also run to inspect how the four dimensions of the CTSES differentiated based on the type of program teachers graduated from, teachers' educational level, teaching school level, and teaching experiences. A statistically significant difference was observed exclusively for teaching experience concerning the SM, $F\ (4, 290) = 2.756$, $p < .05$. Specifically, teachers with 10 to 14 years of teaching experience exhibited higher efficacy for enhancing students' motivation compared to their colleagues with teaching experience ranging from 1 to 4 years.

The second-order CFA was performed to test further validation of the four-factor model of CTSES. In other words, the test aimed to confirm that the theorized construct is derived from sub-factors. As shown in Fig. 3, all standardized factor

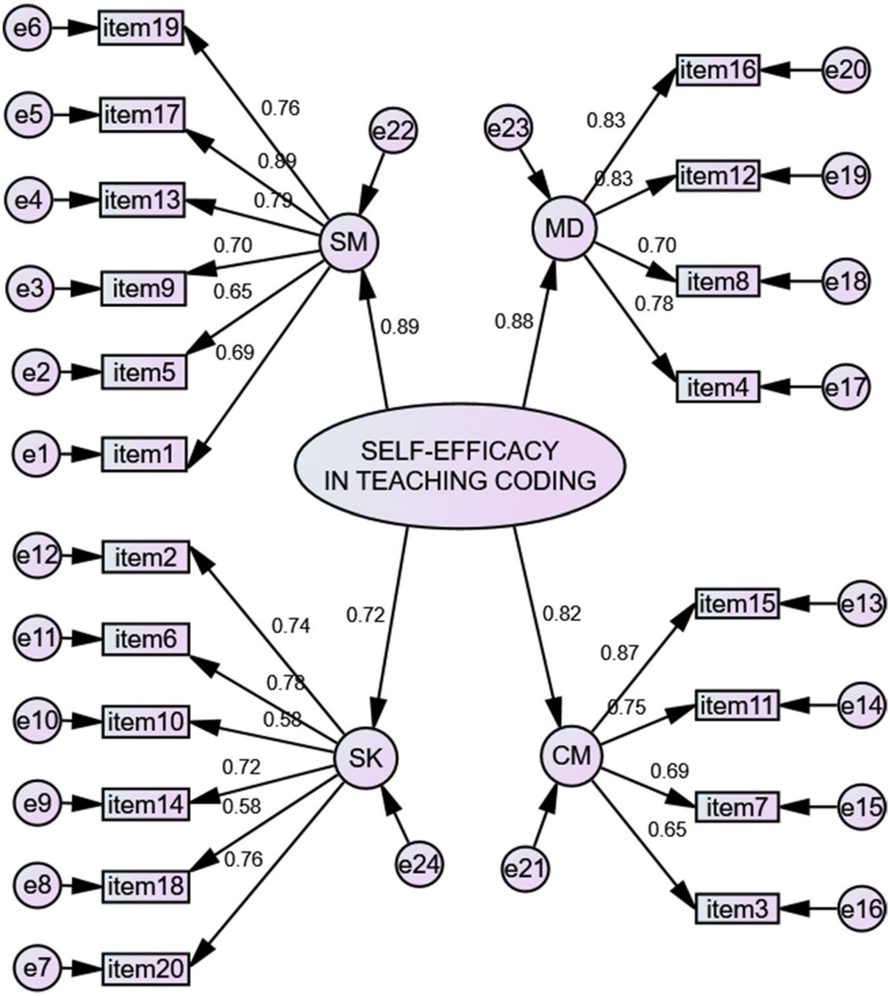

Fig. 3 Factor structure of the second-order four-factor model with 20 items

Table 4 Fit indices for the CFA models

	$\chi2(df)$	$\chi2/df$	CFI	RMSEA	SRMR
First-order	445.311 (164)	2.72	0.914	0.076	0.067
Second-order	469.249 (166)	2.83	0.908	0.079	0.073

$\chi2/df$ = normed chi-square

loadings were significant at $p < .001$, meaning that each CTSES subscale contributed significantly to the model. Besides, as shown in Table 4, there was a slight deviation in fit indices from the first-order to second-order CFA model, which is evidence that the proposed higher construct, teachers' self-efficacy in teaching coding, loads into four underlying components.

9 Discussion and conclusion

In this study, the primary focus is to develop a robust psychometric instrument, namely the CTSES, which was explicitly designed to measure the self-efficacy of CS teachers in the context of coding instruction within K-12 education. The formulation of this scale involved a meticulous and comprehensive research process aimed at ensuring its validity and reliability as a psychometric instrument. The objective was to capture the perceived efficacy of CS teachers when it comes to teaching coding. To ensure the self-efficacy of CS teachers in teaching coding was accurately measured, the scale items were carefully created from transcripts obtained through in-depth interviews conducted with highly qualified CS educators. The validation process produced compelling evidence, affirming the CTSES as a reliable and valid tool for gauging the self-efficacy of in-service CS teachers in the delivery of coding education at the K-12 level.

The foundation of the CTSES is rooted in Albert Bandura's theoretical framework of self-efficacy, which draws on cognitive theory and previous empirical findings from Bandura's works (Bandura, 1977, 1993, 1997). The CTSES identifies four key determinants of self-efficacy in this context: student motivation, subject knowledge, classroom management, and material development. In essence, each of these dimensions is significantly impacted by a CS teacher's efficacy in teaching coding to K-12 students, collectively representing the multifaceted nature of self-efficacy (Bandura, 1993).

The strengths of the CTSES lie in its multidimensional approach, contextual relevance, sensitivity to the unique challenges CS teachers face, potential for educational improvement, and ability to offer a holistic understanding of teacher self-efficacy. Firstly, by recognizing the multifaceted nature of self-efficacy, the CTSES differs from prior scales that treat self-efficacy as a unidimensional construct (Boulden et al., 2021; Rich et al., 2021b). Our research demonstrates that CTSES effectively captures various dimensions of self-efficacy related to teaching coding, each significantly contributing to the overall self-efficacy construct. The multilayered structure enables CTSES to encapsulate the intricate nature of coding instruction, addressing the diverse challenges and competencies entailed across various facets of the subject.

Second, CTES is purposefully designed as a context-specific tool tailored exclusively for assessing teachers' self-efficacy in teaching coding. Previous scales often focus on CT skills (Boulden et al., 2021; Rich et al., 2021b; Tschannen-Moran & Hoy, 2001; Zhou et al., 2020) by ignoring the need for a subject-specific instrument, as underscored by Bandura (1977).

Thirdly, the current study exclusively involved CS teachers with degrees from CS-related departments and actively taught coding to K-12 students. In contrast, previous scale developments often drew data from a broader teacher sample, regardless of their CS expertise (Boulden et al., 2021; Rich et al., 2021b; Zhou et al., 2020).

Fourth, the current study explored the influence of teachers' demographic characteristics, such as gender, age, teaching experience, and coding knowledge, on the four dimensions of CTSES. Notably, only teaching experience and coding knowledge yielded a significant impact. This finding diverges from previous studies (Boulden et al., 2021) but aligns with others, demonstrating a significant increase in teachers' self-efficacy after coding training (Rich et al., 2021b; Zhou et al., 2020). Consequently, this study suggests that CS teachers with greater experience in teaching coding tend to exhibit higher levels of self-efficacy, particularly evidenced by the observed significant differences in the dimension of student motivation.

Fifth, by comprehensively encompassing the various dimensions of self-efficacy relevant to coding instruction, CTSES fosters a holistic understanding of educators' confidence and efficacy levels. This comprehensive standpoint can inform instructional strategies, curriculum design, and support systems to optimize the learning experience for K-12 students. Moreover, the development of the CTSES holds promising implications for educational improvement. By identifying areas where CS teachers may lack confidence in coding instruction, educational institutions, and policymakers can tailor professional development programs to address these concerns effectively, ultimately enhancing the quality of coding education in K-12 settings.

10 Implications

The results of the study, which highlight the significant influence of teaching experience and self-reported coding knowledge on teacher self-efficacy, provide valuable insights with practical implications for improving coding education. These findings go beyond simply recognizing the impact on teacher confidence; they offer the opportunity to influence student achievement positively.

Educational institutions can design targeted teacher training programs by understanding the factors influencing teachers' self-efficacy in coding education. These programs can be specifically tailored to address the identified areas of concern, ultimately fostering greater teacher confidence. As a result, teachers who feel more competent and confident in their coding instruction are likely to create a more engaging and effective learning environment for students.

In addition, the identified dimensions of self-efficacy, such as student motivation, subject knowledge, classroom management, and materials development, can guide curriculum developers in designing resources that meet teachers' needs. By addressing these specific aspects of self-efficacy, educational materials can be designed to enhance teachers' effectiveness in teaching coding skills to students. This, in turn, can positively impact the quality of coding education at the K-12 level.

Beyond the immediate implications for teacher training and curriculum development, the CTSES holds promise for ongoing research and evaluation in coding education. As a comprehensive instrument, it provides a nuanced understanding of the multifaceted nature of teacher self-efficacy. Researchers can use the CTSES to delve deeper into the dynamics between teacher self-efficacy and student outcomes.

In addition, the CTSES can contribute to the continuous improvement of coding education in schools. By aligning with evolving educational needs and technological advances, the scale can guide educators and policymakers in making informed decisions to improve the overall quality of coding education. In this way, the CTSES becomes not just an assessment tool but a catalyst for positive change and progress in coding education.

11 Limitations and further studies

While the present study aimed to develop and validate the CTSES, several limitations warrant consideration. Firstly, the sample size was confined to a specific geographic region, potentially limiting the generalizability of findings to a broader population of CS educators. In addition, the scale's validation process primarily relied on self-report measures, which could introduce response bias.

Future research could address these limitations by conducting large-scale, cross-cultural studies to enhance the external validity of the scale. Additionally, incorporating classroom observations or peer evaluations could provide a more comprehensive assessment of teachers' self-efficacy in actual coding instruction settings. Longitudinal studies may also shed light on the stability of self-efficacy beliefs over time and their impact on teaching practices.

Furthermore, investigating the scale's applicability across different educational levels (e.g., primary, secondary, tertiary) and various coding languages or pedagogical approaches could offer a more nuanced understanding of its utility. Long-term studies examining the relationship between self-efficacy and student learning outcomes might elucidate the role of teachers' confidence in coding instruction effectiveness.

Further research is essential to establish a robust groundwork confirming the validity of the present scale. This is because the development and refinement of an instrument is an evolving and gradual procedure, necessitating the incorporation of various forms of reliable evidence from many sources (Holmbeck & Devine, 2009; Smith & McCarthy, 1995). It is vital for forthcoming studies to prioritize the accumulation of corroborative evidence to enhance the credibility of the scale, thus establishing a stronger foundation for its validity.

Appendix

Table 5 Interview protocol form

1. Purpose	
The purpose of this study is to examine the self-efficacy of computer science teachers in teaching coding. It aims to identify factors influencing their teaching effectiveness, motivation, and classroom management within the context of coding education. Through semi-structured, open-ended interviews, the study seeks to gather in-depth qualitative data from teachers about their experiences, challenges, and strategies in teaching coding. The goal is to uncover insights that can inform the development of supportive strategies and policies to enhance the self-efficacy and overall effectiveness of computer science educators.	
2. Interview Details	3. Participant Information
Interviewer: …………………….	Name of Participant: …………………….
Date: …………………….	School/Organization: …………………….
Duration: …………………….	Years of Teaching Experience: …………………….
Location: …………………….	Age: …………………….
4. Consent	
[Details about informed consent, confidentiality, and the right to withdraw]	
5. Interview Questions	
1. Can you describe your experience and approach when it comes to teaching coding? How do you adapt your teaching style to meet the varying needs of your students?	
2. How confident do you feel about your ability to teach coding effectively? Can you share any specific experiences that have influenced this perception?	
3. What are some of the most significant challenges you have faced while teaching coding? How did you overcome these challenges, and what impact did these experiences have on your teaching self-efficacy?	
4. In what ways have you sought to improve your skills and knowledge in teaching coding? How have these efforts impacted your confidence and effectiveness as a teacher?	
5. How do you gauge your students' understanding and engagement in your coding classes? Can you provide examples of strategies you use to enhance student learning and interest in coding?	
6. How do you integrate various resources and tools into your coding curriculum? What role do this play in shaping your teaching methods and self-efficacy in delivering coding education?	
7. Can you share a particularly successful experience or a breakthrough moment you had while teaching coding? How did this experience contribute to your sense of self-efficacy as a computer science teacher?	

Table 6 Original and translated versions of the CTSES

#	Item	Original Items (in Turkish)	Translated Items (in English)
Item 1	SM_1	Öğrencilerin kodlamaya yönelik olumlu tutum geliştirmelerini sağlayabilirim.	I can help students develop positive attitudes towards coding.
Item 5	SM_2	Kodlama konusunda isteksiz öğrencilerin motivasyonlarını arttırabilirim.	I can increase the motivation of students who are reluctant to code.
Item 9	SM_3	Kodlama öğretimi sürecinde öğrencileri yaratıcı düşünme konusunda destekleyebilirim.	I can support students in creative thinking during the coding teaching process.
Item 13	SM_4	Öğrencileri kodlama konusunda başarılı olabileceklerine ikna edebilirim.	I can convince students that they can be successful in coding.
Item 17	SM_5	Öğrencilerin kodlamaya yönelik ilgilerini arttırabilirim.	I can increase students' interest in coding.
Item 19	SM_6	Öğrencilerde kodlamaya yönelik merak uyandırabilirim.	I can arouse students' curiosity about coding.
Item 2	SK_1	Bir problemin çözümü için doğru algoritmayı oluşturabilirim.	I can create the right algorithm for solving a problem.
Item 6	SK_2	Algoritması verilen bir programın sonucunu belirleyebilirim.	I can determine the outcome of a program whose algorithm is given.
Item 10	SK_3	Kodlama bilgilerimi güncel tutabilirim.	I can keep my coding knowledge up to date.
Item 14	SK_4	Veri, operatör, karşılaştırma, döngü gibi temel kodlama kavramlarını açıklayabilirim.	I can explain basic coding concepts such as data, operator, comparison, loop.
Item 18	SK_5	Bir problemin çözümüne yönelik kodu herhangi bir programlama dilinde yazabilirim.	I can write code for solving a problem in any programming language.
Item 20	SK_6	Bir kod parçasındaki hataları ayıklayabilirim.	I can debug a piece of code.
Item 3	CM_1	Kodlama etkinlikleri sırasında öğrencilerin sınıf kurallarına uymalarını sağlayabilirim.	I can ensure that students follow the classroom rules during coding activities.
Item 7	CM_2	Kodlama etkinlikleri sırasında oluşabilecek olumsuz öğrenci davranışlarıyla baş edebilirim.	I can deal with negative student behaviors that may occur during coding activities.
Item 11	CM_3	Kodlama etkinlikleri sırasında sınıf güvenliğini sağlayabilirim.	I can ensure class safety during coding activities.
Item 15	CM_4	Kodlama etkinlikleri sırasında sınıf yönetimini sağlayabilirim.	I can provide classroom management during coding activities.
Item 4	MD_1	Öğrenci seviyesine uygun öğretim materyali hazırlayabilirim.	I can prepare teaching materials suitable for the level of the student.
Item 8	MD_2	Kodlama becerilerini ölçmek için uygun değerlendirme araçları geliştirebilirim.	I can develop appropriate assessment tools to measure coding skills.
Item 12	MD_3	Öğrenci seviyesine uygun kodlama etkinlikleri düzenleyebilirim.	I can organize coding activities suitable for the student level.
Item 16	MD_4	Kodlama etkinliklerine uygun öğretim materyalleri hazırlayabilirim.	I can prepare instructional materials suitable for coding activities.

**SM* Student Motivation, *SK* Subject Knowledge, *CM* Classroom Management, *MD* Material Development

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Data availability The anonymized datasets analyzed during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval Necessary ethical approval was obtained from the Applied Ethics Research Center of the researchers' university.

Conflicts of interest/Competing interests There is no conflict of interest among authors.

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