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Adaptation of T-STEM CT Scale to Turkish: Teacher Self-Efficacy and Outcome Expectancy for Teaching Computational Thinking

Mustafa Sarıtepeci[1]
Necmettin Erbakan University

Aykut Durak[2]
Ministry of National Education

Abstract

Computational thinking (CT) skills are accepted as fundamental literacy. Although the idea that K-12 teachers should teach students CT skills in an interdisciplinary context is heavily expressed, there is a need for a measurement tool in Turkish that measures teachers' self-efficacy in this regard. This study aims to adapt the T-STEM CT scale, developed by Boulden et al. (2021), into Turkish and to carry out validity and reliability studies of this scale. The original scale consists of a 5-point Likert scale and 13 items. The participants of this study consisted of 168 teachers from different branches working in K-12 schools. It was carried out by selecting for application purposes and a convenient sampling method. Various validity and reliability methods were used to validate the scale. According to the results, the two-factor (Factor1: T-STEM CT self-efficacy, Factor2: T-STEM CT outcome expectancy) and thirteen-item structure had an acceptable fit with the data. Consequently, the validity and reliability of a Turkish tool measuring teaching efficacy beliefs for computational thinking skills were confirmed.

Key Words

In-service teachers • Scale adaption • Computational thinking • Self-efficacy

[1] **Correspondance to:** Faculty of Ereğli Education, Necmettin Erbakan University, Konya, Turkey. E-mail: mustafasaritepeci@gmail.com **ORCID:** 0000-0002-6984-0652
[2] Ministry of National Education, Bartın, Turkey. E-mail: aykdur78@gmail.com **ORCID:** 0000-0001-7070-9048
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Computational thinking (CT) is one of the fundamental skills that all individuals need to learn and develop today (Wing, 2006, 2008). There are many definitions, learning contexts, and assessments studies on this concept (Aho, 2012; Durak & Saritepeci, 2018; Saritepeci, 2020; Wing, 2014; Yadav et al., 2014; Yildiz Durak et al., 2021). Although there is no consensus definition in the literature, CT is concerned with the effective use of information technology concepts and procedures in solving complex problems (Hsu et al., 2018; Shute et al., 2017). CT skills help individuals understand issues in various fields and use their solutions to cope with the challenges posed by the complicated digital world (Zhao et al., 2022). In summary, CT skill is the problem-solving process and way of thinking, in which designs produced with communication technologies supported or unplugged activities to the solution of problem situations (ISTE, 2016b; Wing, 2014). CT refers to a context that includes the use of various high-level skills (algorithmic thinking, problem-solving, abstract thinking, creative thinking, critical thinking, etc.) (Basogain et al., 2012; Sarıtepeci & Durak, 2017). Bundy (2007) claims that CT is used in many learning areas through problem-solving processes and is indispensable for every discipline. Barr and Stephenson (2011) emphasized that CT is a skill associated with self-confidence and perseverance in problem-solving skills.

The interest of policymakers and educators regarding CT and the view that CT should be included in the curriculum (Boulden et al., 2021; Grover & Pea, 2013; Lai et al., 2021; Lindberg et al., 2019; Mohaghegh & McCauley, 2016) and with the wide acceptance of this view, it has become important to develop standards for teachers and students for the use of technology in learning and teaching processes (e.g. ISTE, 2016a, 2016b) and to include CT among the basic skills that students should acquire.

Sanford and Naidu (2016) accentuate the expectations of today's society and the need to train individuals who are competent in terms of CT skills to solve complex 21st-century problems. While Boulden et al. (2021) state that CT is an integral part of the 21st-century life skill required for digital citizenship, Zhao et al. (2022) highlight CT as an essential skill for the daily life of every citizen in the age of information technology. The concurrence that CT is a core skill to acquire requires (Atmatzidou & Demetriadis, 2016; Barr et al., 2011; Papadakis, 2022; Saritepeci, 2020; Wing, 2006, 2008) that K-12 level in-service teachers have the competence to teach and integrate CT into their classrooms (Saritepeci, 2021). In this context, teachers' self-efficacy in integrating technology into the learning and teaching processes is of great importance (Özgün & Saritepeci, 2021; Yildiz Durak, 2021). Therefore, assessing teachers' self-efficacy in this subject is critical for effective teaching of CT. Indeed, self-efficacy is the level of belief that one has the competence to perform a task. We consider that this tool will provide practical benefits for teacher education policymakers and pre-service teacher training.

Purpose of the Study

The current study aims to adapt the T-STEM CT scale developed by Boulden et al. (2021) into Turkish and carry out validity and reliability studies of the scale. In this context, we sought a response to the following research question.

- How is the validity and reliability of the "T-STEM CT Scale" adapted into Turkish?

Method

Participants

The participants consist of 168 in-service teachers who are actively working in K12 schools in various regions of Turkey. All of the participants work in public schools. 48.80% of the participants are female, and 51.20% are male. The average age is 34.80, the age range varies between 23 and 61, and the average seniority is 11.1 years.

The T-STEM CT scale consists of 13 items. It is substantial to determine the item-responder ratios in determining the sample size. For this reason, we reviewed the suggestions in the literature. There are different suggestions in the literature regarding the number of respondents for each item in the scale: For example, three-six respondents according to Cattell (2012), at least five respondents according to Gorsuch (1983), five-ten respondents according to Bryman and Cramer (2002) are enough. In this context, we found it sufficient for each item in the scale to be answered by 12.92 respondents. Considering the relevant literature, the determined number of respondents means a sufficient and generalizable sample size for the current study.

Research Instruments and Data Analysis

The T-STEM CT scale, developed by Boulden et al. (2021), was adapted into Turkish in this study. The original scale consists of 2 factors (teachers' self-efficacy and outcome expectancy beliefs for teaching CT) and 13 items. There are seven items on the scale for the CT self-efficacy factor and six items on the CT outcome expectancy factor. These items are in a 5-point Likert structure: Strongly disagree (1), disagree (2), neither agree nor disagree (3), agree (4), and strongly agree (5).

To adapt the scale, we first requested permission to use the scale from Danielle Cadieux Boulden's correspondence address via e-mail. Following this, two field experts who know both Turkish and English languages translated the scale into Turkish, and two different translators translated the Turkish version back into English. In this process, we discussed the contextual meaning and intelligibility of each item of the scale with experts. We compared the three lists of items that emerged with the translation-re-translation processes, made the necessary adjustments, and created a draft form. After this process, two experts and two teachers who had experience with the subject area evaluated the scale form in terms of meaning and intelligibility. As a result of these reviews and evaluations, we created the final scale form.

We used confirmatory factor analysis (CFA) in the analysis of the data in the study. CFA is an analysis that tests a model related to an existing theory or a predefined structure (Çokluk et al., 2014; Hair, 2009). In this study, since T-STEM CT is a scale with a previously defined factor structure, we decided to test the factorial validity of the scale with CFA in adapting it to Turkish. In the study, descriptive statistics and CFA analyzes were performed in Jamovi 2.2.5 (R Core Team, 2020; Rosseel, 2018; The Jamovi Project, 2021).

Results

We tested the factorial structure of the CT T-STEM scale, which consists of two factors and 13 items, with CFA. According to the CFA results, (x^2 / df=2.469, CFI=.948, TLI=.938, SRMR=.0398, RMSA=.0938) the RMSA values were outside the acceptable range (Browne & Cudeck, 1993). Thereupon, residual covariance -

modification indices review, we combined the error variances of item pairs SE03-SE06 and SE05-SE07. Following this, the goodness of fit values (x^2 / df=1.984, CFI=.966, TLI=.957, SRMR=.0397, RMSA=.0767) shows that the measurement model, which includes the relationship between scale factors and items, has an acceptable fit or/and a perfect fit (Bentler & Bonett, 1980; Browne & Cudeck, 1993; Kline, 2016; Tabachnick & Fidell, 2007). In addition, item factor loads are between .66-.91 (see Figure 1).

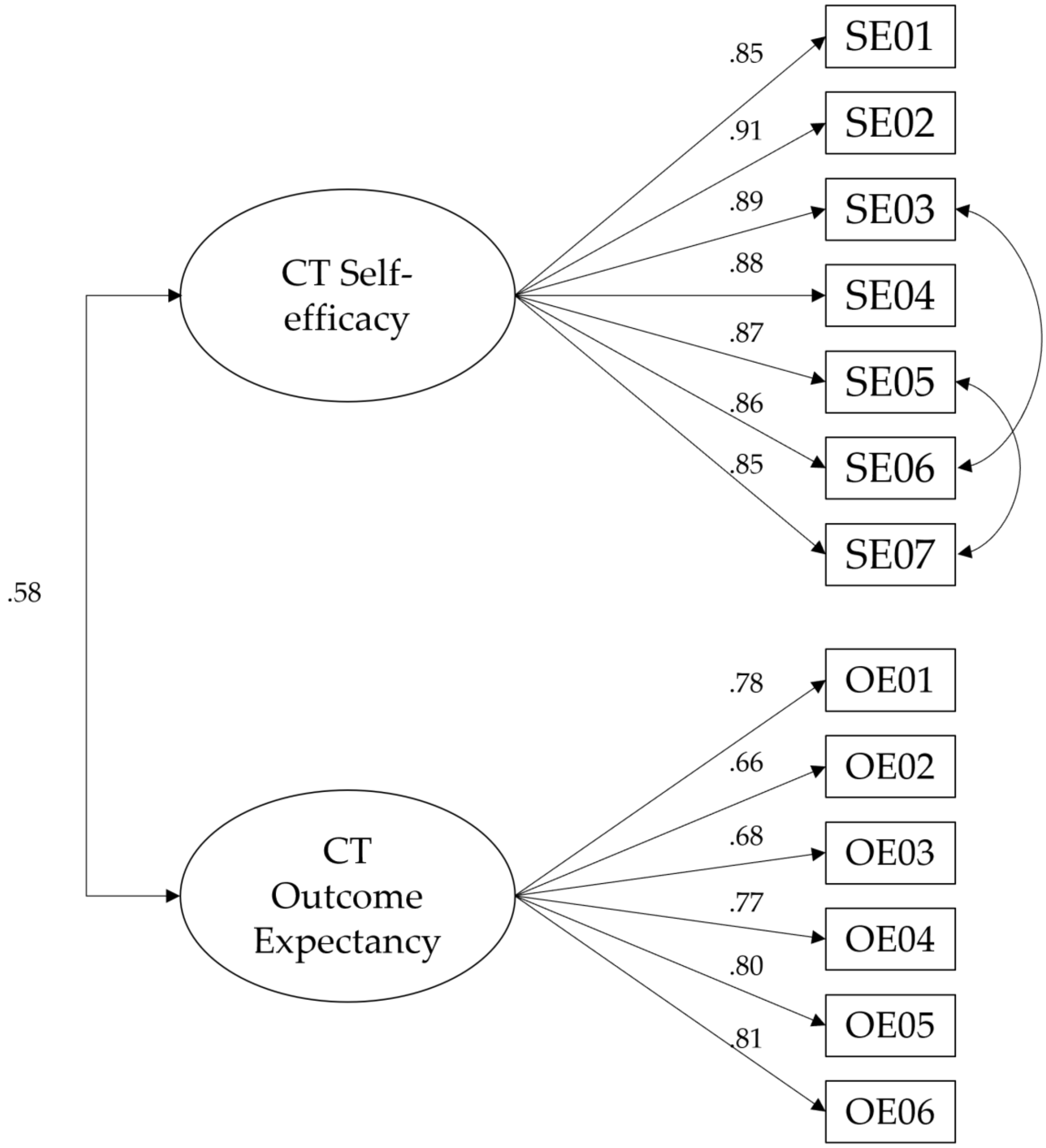

Figure 1. CFA Model for CT T-STEM

To determine the reliability and convergent validity level of the scale, we reviewed the average variance extracted (AVE), composite reliability, and Cronbach alpha values (see Table 1). For both factors, AVE is higher than .50, composite reliability greater than .70, and Cronbach Alpha greater than .70. The results indicate that the scale has good reliability, and convergent validity is achieved (Bagozzi & Yi, 1988; Gefen et al., 2000; Hair, 2009).

According to descriptive statistics, the mean score of the CT T-STEM scale is 46.10. CT Self-efficacy factor mean score is 24.80, and CT outcome expectancy factor is 21.30 (see Table 1). Accordingly, the participants' perceptions of CT self-efficacy and CT outcome expectancy are relatively high.

Table 1

Factor loading, AVE and reliability

Sub-scale	M	Sd	Factor loading	AVE	Composite Reliability	Cronbach Alpha
CT Self-efficacy	24.80	6.68		0.761	.957	.957
SE01			0.847			
SE02			0.905			
SE03			0.894			
SE04			0.884			
SE08			0.869			
SE06			0.859			
SE07			0.846			
CT Outcome Expectancy	21.30	3.55		0.567	0.886	.883
OE01			0.782			
OE02			0.659			
OE03			0.678			
OE04			0.768			
OE05			0.802			
OE06			0.814			

Notes: The CT T-STEM scale is a 5-point Likert scale (“strongly disagree” …. “strongly agree”) structure.

According to Table 2, the diagonal values (square roots of AVEs) are higher than the value in the rows and columns. These results show that discriminant validity is provided.

Table 2

Discriminant Validity

		[1]	**[2]**
CT Self-efficacy	**[1]**	**.872**	
CT Outcome Expectancy	**[2]**	.550	**.753**

Discussion

Integration of learning-teaching activities into different courses for the teaching and development of CT skills is included in the literature as a considerable requirement (Grover & Pea, 2013; Lee et al., 2014; Qualls & Sherrell, 2010; Weintrop et al., 2016). As a matter of fact, in recent years, studies on the integration of CT-related concepts and skills in different disciplines into the curriculum have found more space in the literature (Bell & Bell, 2018; Gadanidis, 2017; Rubinstein & Chor, 2014; Wolz et al., 2011). One of the substantial elements of such integration activities in learning-teaching processes is teachers. In this context, teachers' self-efficacy and outcome expectancy beliefs are two critical factors in integrating CT skills into course processes. The level of self-efficacy in any subject is one of the most fundamental indicators of whether the individual will fulfill the task related to this subject. The weak self-efficacy belief in integrating CT into the course processes will cause the teacher to be distant from such integration efforts. Another determinant of the successful performance of a task is the expectations regarding the results (Guo et al., 2015). The expectancy-value theory considers the expectation about the outcome and the values attributed to this task as the main ingredients in explaining the motivation of individuals to perform a task (Wigfield & Eccles, 2000). Accordingly, teachers' self-efficacy and outcome expectancy levels are essential determinants in integrating CT into their course processes. In this context, in this study, we aimed to adapt the T-STEM CT scale, developed by Boulden et al. (2021), into Turkish and to carry out validity and reliability studies of the scale.

We used CFA for the Turkish adaptation of the T-STEM CT instrument since it has a predefined structure. According to the results, the two-factor and thirteen-item structure had an acceptable fit with the data. This structure provided convergent and discriminant validity and had high internal consistency.

CT is a much newer concept for educators, especially at the K12 level (Li et al., 2020). Therefore, in the usage of this instrument, we recommend providing a CT description in the data collection tool for participants to refer to it. For this purpose, we prefer to consider the CT indicators descriptions in the ISTE (2016) student standards.

Ethic

In this study, all scientific ethical rules were followed.

Author Contributions

All stages of the study were organized and conducted by the authors.

Conflict of Interest

In addition, the authors declare that they have no conflict of interest.

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