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Preschool Teachers' Coding and Computational Thinking Skills: A Scale Adaptation Study

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Abstract

This study aimed to adapt the Teacher Beliefs about Coding and Computational Thinking Scale (TBaCCT) developed by Rich et al. (2021), which measures preschool teachers' beliefs on coding and computational thinking, into Turkish and preschool education and to analyze the psychometric properties of the scale. The research group includes 201 preschool teachers. In this context, the convenience sampling method was used. Various data analyses were performed, including confirmatory factor analyses, item and factor loadings, model fit indices, and Cronbach's alpha internal consistency coefficients, to assess the validity and reliability of the measurement instrument. Based on Confirmatory Factor Analysis findings regarding construct validity, it was determined that one of the goodness-of-fit indices was acceptable, and the other four values showed excellent fit. It was seen that the 4-dimensional structure of the 33 items of the original scale was confirmed within the scope of this research. In this context, the adapted scale consists of 4 dimensions and 33 items. Factor values ranged between 0.35-0.92. As a result of the reliability analysis of the scale, it was found that the Cronbach alpha coefficient was 0.91 and the sub-dimensions ranged between 0.87-0.94. The study found that the scale was a valid and reliable way to measure preschool teachers' perceptions of coding and computational thinking.

Keywords: coding, computational thinking, preschool teacher's beliefs.

Okul Öncesi Öğretmenlerinin Kodlama ve Bilgi İşlemsel Düşünme Becerileri: Bir Ölçek Uyarlama Çalışması

Öz

Bu araştırmanın amacı, Rich vd. (2021) tarafından geliştirilen, okul öncesi öğrencilerinin kodlama ve bilgi işlemsel düşünme konusundaki inanışlarını ölçen "Kodlama ve Bilgi işlemsel Düşünme Hakkındaki Öğretmen İnanışları Ölçeği (KBiDHÖİ)"ni Türkçe'ye ve okul öncesi eğitimine uyarlamak ve ölçeğin psikometrik özelliklerini incelemektir. Araştırmanın örneklemini 201 okul öncesi öğretmeni oluşturmaktadır. Bu kapsamda kolay ulaşılabilir durum örneklemesi yöntemi kullanılmıştır. Ölçme aracının geçerli ve güvenirliği ile ilgili olarak doğrulayıcı faktör analizleri, madde ve faktör yükleri incelemesi, model uyum indekslerinin değerlendirilmesi ile Cronbach Alfa iç tutarlılık katsayıları gibi çeşitli veri analizleri yapılmıştır. Yapı geçerliliğine ilişkin Doğrulayıcı Faktör Analizi bulgularına dayalı olarak, uyum iyiliği indekslerinden birinin kabul edilebilir düzeyde olduğu, diğer dört değerin ise mükemmel uyum gösterdiği belirlenmiştir. Orijinal ölçeğin 33 maddesinin 4 boyutlu yapısının bu araştırma kapsamında doğrulanması ortaya konulmuştur. Bu bağlamda uyarlanan ölçek 4 boyuttan ve 33 maddeden oluşmaktadır. Faktör değerleri 0,35-0,92 arasında değişmektedir. Ölçeğin güvenirlik analizi sonucunda Cronbach alfa katsayısının 0,91 olduğu ve alt boyutların 0,87-0,94 arasında değiştiği bulunmuştur. Çalışmada ölçeğin okul öncesi öğretmenlerinin kodlama ve bilgi işlemsel düşünme inanışlarını ölçmede geçerli ve güvenilir bir ölçme aracı olduğu sonucuna ulaşılmıştır.

Anahtar kelimeler: kodlama, bilgi işlemsel düşünme, okul öncesi öğretmen inanışları.

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INTRODUCTION

Education systems are constantly transforming to adapt to the requirements of the digital age. As an important part of this transformation, coding and computational thinking (CT) skills, which are recognized as key elements of 21st century skills, are becoming increasingly crucial (Mendrofa, 2024; Mohaghegh & McCauley, 2016; Tsarava et al., 2018). It is argued that coding and CT should be as fundamental a skill as reading, writing and arithmetic and should be considered as one of the basic literacy areas of the modern world (Bers, 2020; Papadakis, 2022; Resnick & Siegel, 2015; Wing, 2006). Coding and CT, which are new literacies that enable individuals to communicate their ideas and create digital content and are increasingly accepted as a form of personal expression, are considered as basic skills that should be acquired or developed from early childhood due to their fundamental role in meeting the demands of the digitalizing society (Angeli et al., 2016; Bers, 2018, 2020; Grover & Pea, 2013; Resnick & Siegel, 2015; Tsarava et al., 2018).

Coding, considered the fundamental language of the digital age, is central to the functioning of many technological systems, from phones to vehicles (Bers, 2018). Furthermore, the concept of CT is a phenomenon that draws from diverse perspectives, exhibits a dynamic structure, and encompasses methods for imparting coding and programming skills within the education system. In this context, various studies have been conducted to define CT and explain its scope (Barr & Stephenson, 2011; Gonzalez, 2015; Grover & Pea, 2013; Hu, 2011; Kalelioğlu et al., 2016; Wing, 2006, 2008, 2011). In general, definitions emphasize that CT involves the use of computational steps and algorithms to address problems through systematic, precise, and automated processes, and is defined as a disciplinary way of thinking that includes processes such as algorithm design, abstraction, problem solving, and knowledge construction (Aho, 2012; Kalelioğlu et al., 2016; Vujičić et al., 2021; Wing, 2006, 2011). Moreover, the key element that distinguishes CT from traditional problem solving is the ability to transform abstract solutions into automated steps that can be executed by human or machine (Wing, 2006). While some researchers associate CT with technical skills such as debugging, simulation, or algorithm generation, others emphasize its cognitive aspects such as strategic thinking, critical thinking, and iterative reasoning (Barr & Stephenson, 2011; Gonzalez, 2015; Grover & Pea, 2013; Hu, 2011; Kalelioğlu et al., 2016; Wing, 2006, 2008, 2011). Since coding and CT overlap highly in terms of cognitive processes, they are often not considered separately from each other. Increasing coding proficiency positively affects CT development, showing that these two constructs mutually feed each other. In addition, coding is also important as a tool to support the development of CT skills. Coding and CT skills are not just tools for acquiring technical knowledge today. They are also directly related to 21st-century learning objectives such as creativity, communication, and collaboration, and play a significant role in the social and cognitive development of individuals (Papadakis, 2022). In this respect, coding and CT offer students multifaceted contributions in the educational process. The core components of CT include problem solving, decomposition, abstraction, algorithm design and evaluation, pattern recognition, modeling, and debugging (Beecher, 2017; Çetin & Toluk Uçar, 2017). These skills help individuals break down complex problems into smaller, more manageable components, focus on solutions by avoiding unnecessary details, and develop a systematic thinking structure. Similar components are also prominent in the coding process. Elements such as algorithm creation, modularity, decomposition, and debugging largely overlap with the fundamental principles of CT (Bers, 2020). These processes contribute not only to the acquisition of technical skills but also to the development of logical and systematic thinking habits. Indeed, the processes of generating solutions to problems through technology and adapting these solutions to different situations strengthen CT skills (Göncü et al., 2018; Kesici & Kocabaş, 2006). However, coding and CT are not the same concepts. While coding is considered an important component of CT, CT encompasses a much broader intellectual framework, including problem solving, analysis, decomposition, and algorithmic thinking (Bocconi et al., 2016).

Coding and CT education are seen as a core subject in many developed countries around the world and are integrated into the curriculum as a compulsory or elective subject (Angeli et al., 2016; Bers, 2020; Gretter & Yadav, 2016; Liu et al., 2024; Mills et al., 2024; Sands et al., 2018; Voogt et al., 2015). The inclusion of coding and CT in the curricula of countries such as United Kingdom, Australia, the United States, Denmark, Malta, Poland, Portugal, Spain, Slovakia, Bulgaria, France, Israel, the Czech Republic, Estonia, Hungary, Lithuania, Ireland, Finland, and Belgium (Aranda & Ferguson, 2018; Bocconi et al., 2016; Mills et al., 2024; Uzunboylu et al., 2017) shows that there is a growing awareness that these skills contribute to innovation, digital literacy, and interdisciplinary learning (Aranda & Ferguson, 2018; Bocconi et al., 2016; Mills et al., 2024). Also, in Türkiye, coding education has been incorporated into the national curriculum with a particular emphasis on the secondary school level, reflecting a global trend toward integrating CT into formal education. One of the notable initiatives in this area is the “I Discover Coding” project, designed specifically for 5th grade students, which combines both computerized and unplugged activities to introduce the fundamental logic of programming (Kalelioğlu, 2018). This project not only familiarizes students with basic programming concepts but also aims to cultivate problem-solving skills, algorithmic reasoning, and creativity from an early age, and the Ministry of National Education (MoNE) has systematically integrated CT-oriented content into the Information Technologies and Software curricula since 2012 (MoNE, 2016, 2018).

These curricula include explicit learning objectives such as designing algorithms, applying conditional statements, working with variables, and engaging in debugging processes. Moreover, by embedding CT into formal schooling from primary to secondary levels, Türkiye’s education system is fostering the formation of digitally literate individuals who can actively participate in and contribute to a technology-driven society (Kalelioğlu, 2018; MoNE, 2016, 2018). When this perspective is extended to earlier ages in education, an examination of pre-school programmes in Türkiye reveals that the 2013 curriculum did not directly include coding or CT but indirectly fostered algorithmic thinking through skills such as problem solving, logical reasoning, and pattern recognition (MoNE, 2013). In contrast, in the 2024 programme, coding and algorithmic thinking have been explicitly included in the curriculum under Learning Outcomes 15 and 25; the aim is for children to develop skills such as spatial positioning, sequence of operations and debugging through coding-based activities (MoNE, 2024a). The Türkiye Century Education Model, published in the same year, focuses on mathematical reasoning and relates coding and symbolic representations to mathematical learning processes (MoNE, 2024b). Thus, the content that was indirectly present in 2013 has been directly and holistically integrated into the programme as of 2024. In this regard, it is recommended that coding and CT be presented as part of early childhood education using an age-appropriate and gradual approach. This approach should begin with disconnected activities and fun problem-solving exercises at an early age and transition to block-based and then text-based programming in later grades (Angeli et al., 2016; Bers, 2018). One of the most effective methods in the children's learning process, learning by doing and experiencing, is explained based on Piaget's constructivist approach and Papert's constructivist theory. According to Papert's theory, it is critically important for children to learn by doing, develop ideas through concrete objects, strengthen themselves with powerful ideas, and deepen their learning through self-reflection (Bers, 2018; Papert, 1980, 1996). Within this framework, it is recommended that children first become familiar with coding concepts using concrete materials and then transition to the digital environment (Bers, 2020; Saxena et al., 2020). At these stages of the process, coding stories, games, and unplugged activities offer children the opportunity to learn basic concepts such as direction, sequence, and movement in a fun and interactive way (Lee, 2019; Saxena et al., 2020).

The literature consistently highlights that introducing coding in early childhood has a positive impact on children’s knowledge, skills, and attitudes in areas such as coding, CT, and problem-solving. Moreover, experimental studies demonstrate that these benefits are not limited to CT and problem-solving (Bers et al., 2014; Masarwa et al., 2024; Papadakis, 2021) but also extend to transferable 21st-century skills, including collaboration, creativity, and perseverance (Nouri et al., 2020). The extent to which students can successfully achieve these goals depends on the competence and pedagogical approach of teachers, who play a key role in imparting these skills and competencies to learners (Rich et al., 2021; Saxena et al., 2020; Yadav et al., 2016). Teacher professional development is a key factor in this process, as ongoing and practice-oriented training equips educators with both the necessary subject knowledge and the pedagogical skills to integrate CT effectively into their teaching (Yadav et al., 2016). Furthermore, research emphasizes that the successful incorporation of CT into classroom practice is strongly shaped by teachers’ technological pedagogical content knowledge as well as their underlying beliefs and attitudes (Angeli et al., 2016; Voogt et al., 2015). Therefore, investing in comprehensive, continuous professional development not only equips teachers with the necessary skills but also fosters confidence and pedagogical creativity in implementing coding and CT activities (Ausiku & Matthee, 2023; Avşar, 2023; Cabrera et al., 2021; Rich et al., 2021; Saxena et al., 2020; Yadav et al., 2016). Despite this positive potential, the literature reveals that the current situation does not always occur as expected, and it has been found that teachers lack the skills in question and experience various deficiencies in acquiring these skills (Khanlari, 2016; Liu et al., 2024; Mills et al., 2024; Ogegbo & Ramnarain, 2022; Rich et al., 2021). Existing studies show that even if teachers have received coding and CT training, they may not have a sense of self-efficacy to teach in these areas (Aytaç, 2021; Rich et al., 2021). Therefore, it is important to include hands-on experiences in teacher training programs and to improve teachers' self-efficacy in these areas (Mason & Rich, 2020). Self-efficacy for teaching is defined as a teacher's beliefs about his/her own efficacy for student learning and engagement (Tschannen-Moran & Hoy, 2001). These beliefs influence a teacher's perception of his/her ability to teach a particular subject (Rich et al., 2021). Even if teachers' general teaching efficacy is high, their self-efficacy perception in teaching a particular subject may be low, or vice versa, indicating that self-efficacy beliefs are multidimensional and can vary depending on the task a teacher undertakes or the subject they teach (Bandura, 1982, 1997; Tschannen-Moran & Hoy, 2001).

As self-efficacy increases, teachers' classroom practices become more diverse, and these practices are thought to have more positive effects on students (Fang, 1996; Shah, 2023). In order to effectively integrate CT and coding into the classroom, teachers' beliefs about these areas need to be systematically measured with reliable and valid instruments (Cabrera et al., 2021; Rich et al., 2021). In this regard, there is a need for comprehensive scales that address these three fundamental belief dimensions—value beliefs, self-efficacy, and teaching efficacy—together. However, the number of such scales is quite limited (Bean et al., 2015; Kukul et al., 2017; Rich et al., 2021), and most only assess coding or CT knowledge levels or focus on a single dimension of these skill sets. For example, some scales address only self-efficacy (Gülbahar et al., 2018; Özçınar & Öztürk, 2018), only attitude (Karaman & Büyükalan Filiz, 2019), or only knowledge level (Korkmaz et al., 2015; Üzümcü, 2023). Furthermore, it is noteworthy that a significant portion of these tools has been developed directly for students (e.g., Gülbahar et al., 2018; Korkmaz et al., 2015) or teacher candidates (Korkmaz et al., 2017), while multidimensional scales for active teachers are pretty limited. From this point of view, the need for measurement tools that comprehensively assess teachers' beliefs, self-efficacy perceptions, and teaching competence in the areas of coding and CT is clearly evident in the literature. To address this gap, Rich et al. (2021) developed the Teacher Beliefs about Coding and Computational Thinking Scale (TBaCCT) scale to measure elementary school teachers' beliefs about coding and CT. This study aims to make sense of preschool teachers' beliefs about coding and CT and to provide a data-based basis for how these beliefs can be addressed in the context of teacher education. In addition, it aims to contribute to the field by demonstrating the validity and reliability of the adapted scale in Turkish culture and preschool education.

METHOD

Research Design

This study aimed to adapt the Teacher Beliefs about Coding and Computational Thinking (TBaCCT) scale into Turkish and Turkish culture, which measures preschool teachers' coding and CT beliefs. For this purpose, the reliability and validity of the scale were investigated.

Participants

The sample of the study consists of 201 preschool teachers working in different provinces of Türkiye. In the process of determining the sample, the convenience sampling method was used due to its practicality in accessing participants who volunteered to participate in the study (Etikan et al., 2016). In this regard, based on the literature, the sample size is considered sufficient for this study, as it is approximately six times larger than the number of items suggested by Bryman and Cramer (2002) and exceeds 200, which Comrey and Lee (1992) defined as an "appropriate" sample size. Information on the research group's demographic attributes is given in Table 1.

Table 1. Demographic Information of Participants

Variables		F	%	Variables		F	%
Gender	Female	194	96,5	Graduated Department	Preschool Education	164	81,6
	Male	7	3,5		Child Development	37	18,4
Age	20-30	107	53,2	Professional Experience	1-7	106	52,7
	30-40	71	35,3		8-15	69	34,3
	40 and above	23	11,4		16-22	26	12,9
Educational Background	Associate degree	16	8,0	Coding Training Status	Yes	47	23,4
	Bachelor's degree	161	80,1		No	154	76,6
	Master's Degree	24	11,9				

According to gender, 96.5% female and 3.5% male teachers were included in the study group. It was identified that the teachers' professional experience ranged between 1-22 years, the majority of them were between the ages of 21-50, and their educational status consisted of preschool undergraduate, child development associate degree, or bachelor's degree graduates. It was determined that most of the study group teachers had not received coding or CT training before. Teachers who stated they had received coding or CT training generally received online training with their efforts.

Data Collection Tools

The study data were gathered in the 2022-2023 academic year, and all necessary permissions were obtained. In this context, a personal information form and the Teacher Beliefs about Coding and Computational Thinking (TBaCCT) scale were used in the data collection phase of the study.

1. **Personal information form**

In the personal information form developed within the scope of the research, there are questions to gather demographic information about the teachers in the sample. This information includes age, gender, province of teaching, graduation levels and departments, and length of professional experience.

2. **Teachers' Beliefs about Coding and Computational Thinking (TBaCCT) Scale**

Teacher Beliefs about Coding and Computational Thinking (TBaCCT) Rich et al. (2021) developed a self-assessment instrument to determine the factors affecting elementary school teachers' beliefs about teaching coding and CT in their classrooms. A 6-point Likert-type rating (6=Strongly Agree, 5=Agree, 4=Somewhat Agree, 3=Somewhat Disagree, 2=Disagree, 1=Strongly Disagree) is used to assess the teacher's beliefs about CT and coding. There are four sub-dimensions in the scale and 33 items in total. Validity and reliability tests of the scale were conducted. Validity study is the process of verifying the extent to which a scale measures the targeted concept. Before this process, the hypothetical measurement model on which the scale is based and developed based on theoretical foundations is tested (Kline, 2015). In this context, the original form of the TBaCCT scale was considered as a hypothetical model representing a pattern of structural relationships. Within the scope of the research, confirmatory factor analysis (CFA) was used to examine the validity of this model. As a result of the CFA, the scale showed a good model fit, and the standardized factor loadings for the items in the pretest and posttest were all significant and generally high. As part of the reliability analysis of the scale, Cronbach's Alpha Coefficient, which is suitable for parallel or equivalent measurements, was calculated. Cronbach's alpha value calculated for each dimension of the scale: Coding - pre-test=0.918, post-test=0.915; Teach - pre-test=0.943, post-test=0.942; Values Beliefs about Computing - pre-test=0.837, post-test=0.817; Computational Thinking - pre-test=0.669, post-test=0.707. As a result, it was concluded that the scale was reliable (Institute for Advancing Computing Education, 2019).

Methodological Steps (Process Steps) Some steps were taken to adapt the scale to Turkish and Turkish culture. These steps are given in Figure 1.

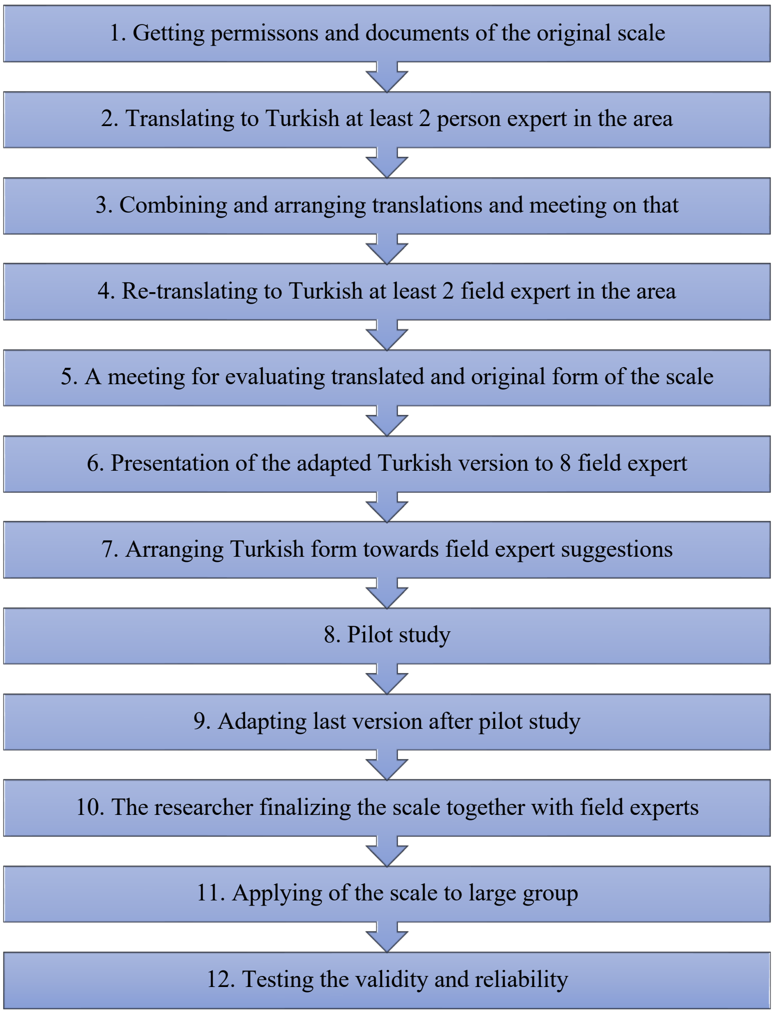

Figure 1. *Scale Adaptation Stages*

The adaptation procedure of the scale was completed in twelve steps based on the methodological approaches suggested by Hambleton et al. (2005). As can be seen in Figure 1, where the adaptation steps of the scale are also included, in Step 1 we contacted Peter Rich via e-mail to obtain permission for the original scale. The required written permission and necessary files were obtained. In addition, while obtaining permission, information was given about adapting the scale to preschool teachers and Turkish culture. In Step 2, the translation of the scale, which was initially in English, was carried out with two experts in the field. One of the teams in this translation phase was an expert in English language education, while the other was an expert in both English language and preschool education. In Step 3, after completing the translations, a meeting was organized with the two experts and the researcher. At the end of this meeting, the Turkish version of the scale was combined, and a single form was created. Since the main purpose of this study was to adapt the scale not only linguistically but also culturally and contextually, the appropriateness of the scale items to Turkish culture and the level of preschool education was specifically considered. The original scale items were developed for primary school teachers; therefore, the statements were reduced to the developmental level of preschool classrooms, adapted to the pedagogical context, and reorganized to be more linguistically fluent and comprehensible. In this process, content adaptations were also made by considering the appropriateness of the scale statements to preschool teaching practices and the cultural characteristics of the early childhood education system in Türkiye. For example, the statement “I can find uses for computer programming that are relevant for students” (Item 3 under the Teaching factor) was revised as “I can find coding activities that are appropriate for children's levels”. In the 4th step, the Turkish form was back translated. At this stage, the form was sent to two experts in English language teaching and translated back into English. In Step 5, a meeting was organized with the participation of these two linguists and the two researchers. At the end of this meeting, the English form of the scale was finalized.

Afterwards, two experts adapted this form for preschool education, and the final version of the Turkish form was created. Geisinger (1994) emphasises that this meeting, which brought together experts and researchers, was organised to reach consensus on both post-translation forms and highlights the importance of collaboration between linguists and subject matter experts in this process. This is because even if the linguists are excellent in their field, there may be items on the adapted scale that they cannot define or need consensus, and they should decide together with the field experts. In the 6th Step, the Turkish version of the form was finalized, and after this stage, the scale was presented to 8 field experts. These eight experts work in the fields of "Preschool Education" (3), "Computer Education and Instructional Technology" (2), "Measurement and Evaluation" (2), and "Turkish Education" (1). In Step 7, the Turkish form was updated and finalized by considering the corrections and feedback in line with the expert opinions. After the final version of the scale was completed, the original and the English form of the scale, which was created after retranslation, were examined. The items of the original scale focus on pre-service elementary school teachers. The scale items were adapted to focus on preschool teachers in this study. For example, "I can find computer programming uses which appropriate for students" was changed to "I can find coding activities appropriate for children's levels". After the translation process was completed, to determine the validity of the scale, the views of three experts in the field of early childhood education and coding-information-processing thinking (one professor and two associate professors) and three experts in the field of Computer Education and Instructional Technology Education (consist of two professors with one associate professor) working at different universities were taken. The appropriateness and comprehensibility of each item in the scale were evaluated within the scope of expert opinions. At this point, a form consisting of 33 rows and four columns (appropriate, partially appropriate, not relevant, and opinions and suggestions) was applied. The feedback received from the experts was evaluated individually, and the content validity of the scale was established by revising the items in line with their suggestions. In the 8th step, the final version of the scale was piloted with 114 teachers working in different provinces. In the 9th stage, after the evaluation of the analyses of the pilot application, it was seen that the fit indices were at acceptable values except for the RMSA value. In the 10th Step, the acceptability of the final version of the scale was evaluated within the researcher's scope. The scale's actual data was applied to 201 individuals in the 11th Step. During the 12th Step, investigations into the validity and reliability of the scale were conducted.

Data Analysis

To evaluate the validity and reliability of the scale in the data analysis of the study, various statistical tests were conducted. To test the validity of the scale, the relationship between the item scores and the total scores of the sub-dimensions was examined using the Pearson correlation coefficient. In this context, it was concluded that the original form of the Teacher Beliefs about Coding and Computational Thinking (TBaCCT) Scale, which was created by utilizing the theoretical ground, was the hypothetical model representing the pattern of structural relationships. As a result, the validity of the model was analysed in the study using confirmatory factor analysis. The AMOS package program was used to verify the 4-dimensional structure seen in the original scale. To obtain proof for the construct validity of the TBaCCT scale, CFA, the method based on a correlation matrix, was applied to explain the latent variables underlying teachers' responses to the scale items. CFA is one of the basic analysis methods commonly used to test construct validity in social sciences or educational sciences (Brown, 2015). The scale used in the study was developed by Rich et al. (2021), who stated that it had a four-dimensional structure in its original form. CFA was therefore carried out to confirm the study's four-dimensional structure. AMOS statistical software was used in the analysis process. Before starting the CFA, normality, linearity (multivariate normality) and the presence of outliers, which are the necessary assumptions for a healthy application of factor analysis, were tested (Büyüköztürk, 2017). In addition, the condition of a sample size of at least 200 people, as recommended in the literature for factor analysis, was also met (Kline, 2015). The unweighted least squares estimation method was preferred in the analysis process to calculate factor loadings. CFA produced factor loadings and goodness of fit indices that were assessed to see if the factor loading values illustrating each item's relationship to the relevant factor were at an acceptable level. Another point is that the Cronbach Alpha Coefficient, suitable for parallel or equivalent measurements, was calculated within the scope of reliability analyses at the reliability testing stage. As a result, the reliability of the scale was evaluated.

Research Ethics

This study was conducted in accordance with the scientific ethical standards set for educational research. Accordingly, the necessary permissions were obtained from the relevant ethics committee before the data collection process. All teachers included in the study were informed about the purpose and scope of the study, and their voluntary participation was ensured through an informed consent form. Participants were informed that their responses would be kept confidential and used only for scientific purposes. Demographic information was collected, but this data was only used in the scientific analysis and reporting process, and personal information was kept strictly confidential. The scales and data collection forms used in the study did not involve any risk, and participants were informed that they could withdraw from the study if they wished without any negative consequences. All stages of the study - design, data collection, analysis and reporting - were conducted in accordance with the principles of honesty, transparency and academic ethics.

FINDINGS

In line with the purpose of the study, the findings regarding the validity and reliability of the scale are presented in a systematic manner. First, the construct validity of the scale was examined through model fit indices and standardized factor loadings using CFA. Following this, the reliability of the scale was evaluated based on internal consistency coefficients (Cronbach's Alpha) calculated for each subdimension and for the overall scale. The findings are presented in the order of analysis.

As part of the construct validity assessment, CFA was conducted to test whether the theoretical four-factor model of the scale adequately fit the collected data. In this context, both standardized factor loadings and goodness-of-fit indices were evaluated to determine the appropriateness of the model.

Table 2. Fit Indices and Reference Values of the Scale of Teacher Beliefs about Coding and Computational Thinking

Fit Indices	Perfect Fit	Acceptable Values	Result
X^2/df	$0 \leq X^2/df \leq 2$	$2 \leq X^2/df \leq 3$	1.441
RMSEA	$0 \leq RMSEA \leq 0.05$	$0.05 \leq RMSEA \leq 0.10$	0.047
CFI	$0.95 \leq CFI \leq 1.00$	$0.90 \leq CFI \leq 0.95$	0.980
TLI(NNFI)	$0.95 \leq TLI \leq 1.00$	$0.90 \leq TLI \leq 0.95$	0.978
NFI	$0.95 \leq NFI \leq 1.00$	$0.90 \leq NFI \leq 0.95$	0.937

The fit indices in Table 2, obtained as a result of Confirmatory Factor Analysis (CFA), show that the four-factor structure of the scale strongly aligns with the data. In particular, the χ^2/df ratio of 1.44 meets the criterion of being below 2 recommended in the literature and indicates that the model shows a very good fit (Çelik & Yılmaz, 2016). Similarly, the RMSEA value of 0.047 is considered to be in the 'excellent fit' range as it is below 0.05 (Tabachnick et al., 2007). The scale's other fit indices are similarly strong: CFI = 0.980 and TLI = 0.978 are above 0.95, indicating excellent fit; NFI = 0.937 falls within the 0.90–0.95 range, indicating an acceptable level of fit (Hooper et al., 2008). When these results are evaluated as a whole, it can be said that both the theoretical framework and the empirically supported structure of the scale are valid.

Table 3. Item and Factor Loadings

Dimension	Item Number	Factor Loading	Dimension	Item Number	Factor Loading	Dimension	Item Number	Factor Loading
Coding	1	0.77	Teaching Competence	1	0.79	Belief in Teaching	1	0.72
	2	0.73		2	0.75		2	0.83
	3	0.74		3	0.85		3	0.74
	4	0.66		4	0.86		4	0.25
	5	0.72		5	0.71		5	0.71
	6	0.73		6	0.81		6	0.66
	7	0.78		7	0.73		7	0.90
	8	0.74		8	0.82		8	0.75
Computational Thinking	1	0.59		9	0.76		9	0.56
	2	0.92		10	0.77		10	0.55
	3	0.91		11	0.64			
	4	0.90						

Factor loadings represent the strength of the relationship between each item and its corresponding latent construct, and they are considered one of the most critical indicators in factor analysis. According to the literature, factor loadings of 0.32 and above are generally accepted as the minimum threshold for interpretability, while values above 0.50 are typically considered practically significant (Tabachnick et al., 2007).

The values presented in Table 3 reveals that the factor loadings for each item across the sub-dimensions of the scale fall within acceptable and mostly strong ranges. Specifically, in the "Coding" sub-dimension, item loadings range from 0.66 to 0.78, while for the "Teaching Competence" sub-dimension, they range from 0.64 to 0.86, both indicating a solid factor structure. In the "Belief in Teaching" sub-dimension, factor loadings vary more widely, from 0.25 to 0.90. These values indicate that the items are strongly associated with the underlying constructions they are intended to measure. While most items in this dimension exhibit satisfactory or strong loadings, one item — "My current teaching environment is NOT suitable for me to teach coding concepts to children" (Item 4) — showed a lower factor loading of 0.25. Although this value is below the generally accepted threshold of 0.30 for inclusion in a confirmatory model (Crocker & Algina, 1986, p. 315), the item was retained in the model due to its theoretical relevance. The conceptual framework of the original scale, Rich et al. (2021), explicitly accounts for contextual and environmental barriers in shaping teachers' self-efficacy beliefs, and this item reflects that dimension clearly. In the "Computational Thinking" sub-dimension, factor loadings range from 0.59 to 0.92, which demonstrates a high degree of alignment between items and their underlying latent factor. When interpreting these findings in terms of practical significance, it is noteworthy that nearly all items exceeded the threshold of 0.40, suggesting that they are strong indicators of the underlying constructs they are intended to measure (Crocker & Algina, 1986, p. 315). The decision to retain a single low-loading item was made based on its conceptual alignment rather than purely statistical criteria, supporting both the content validity and theoretical integrity of the scale.

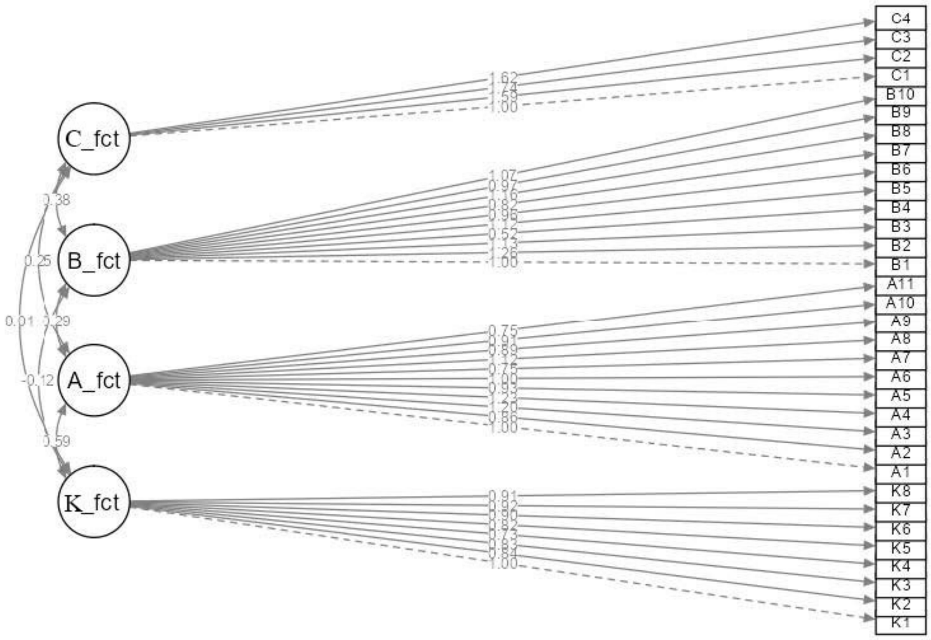

Figure 2. *Path diagram of the CFA model*

The structural relationships between the observed variables and latent constructs and the standardized factor loadings between them are visually represented in the path diagram presented in Figure 2. This diagram provides a graphical overview of the CFA model by showing how each item loads on the relevant factor and how the latent variables are conceptually organized within the overall model. In the path diagram Figure 2, each latent variable is represented by a corresponding letter for ease of interpretation:

C stands for Computational Thinking,

K refers to Coding,

A represents Teaching Competence, and

B corresponds to Belief in Teaching.

These abbreviations were used in the diagram to clearly illustrate the relationships between the latent constructs and their respective observed variables.

Table 4. Reliability Analysis Results

	Total	Coding	Teaching Competence	Belief in Teaching	Computational Thinking
Cronbach-Alpha	0,91	0,90	0,94	0,87	0,90

To evaluate the internal consistency of the scale, Cronbach's alpha (α) coefficients were calculated for both the overall scale and each sub-dimension. Reliability results for the scale are presented in Table 4. The results indicate a high level of internal reliability. Specifically, the total scale yielded a Cronbach's alpha value of α = 0.912, which suggests excellent internal consistency. For the individual sub-dimensions, the reliability coefficients were also found to be high: "Coding" α = 0.904, "Teaching Competence" α = 0.942, "Belief in Teaching" α = 0.866, "Computational Thinking" α = 0.901 and "Total Scale" α = 0.912. According to commonly accepted thresholds in the literature, a Cronbach's alpha value above 0.70 indicates acceptable reliability, while values above 0.80 reflect good to excellent internal consistency (George & Mallery, 2003). In this regard, all four sub-dimensions of the scale, as well as the total scale, demonstrate strong internal coherence, supporting the reliability of the instrument when applied to the current sample. These findings suggest that the scale is a consistent and dependable tool for measuring teachers' beliefs about coding and CT in the context of early childhood education.

DISCUSSION & CONCLUSION

The Teachers' Beliefs about Coding and Computational Thinking (TBaCCT) scale was developed by Rich et al. (2021) to determine teachers' beliefs about coding and CT teaching. This study aims to measure early childhood teachers' beliefs about coding and CT by adapting the scale into Turkish in the context of preschool education. The findings indicate that the cultural adaptation of the scale can be used as a valid and reliable measurement tool. Validity and reliability analyses revealed that the original four-factor structure of the scale was retained, and its psychometric properties were strong. CFA results show that factor loadings ranged from 0.35 to 0.92 in each subscale. The fit indices (e.g., NFI, CFI, RMSEA) confirm the fit of the model. As a result of the reliability analysis of the scale, the overall Cronbach's Alpha value was calculated as 0.91. These findings reveal the consistency of the scale and largely overlap with the psychometric properties of the original scale developed by Rich et al. (2021).

The findings reveal that the factor structure of the scale adapted into Turkish largely corresponds to the original form and provides a valid tool for assessing teachers' beliefs. This indicates that the scale has theoretical consistency that allows it to be used not only in the Turkish context but also in different cultural environments to measure beliefs related to coding and CT. Indeed, the four-dimensional structure validated in the original form developed by Rich et al. (2021) was largely preserved in this study and pointed to the multidimensional nature of teachers' beliefs.

Rich et al. (2021) emphasized that teacher beliefs are multidimensional constructs that include self-efficacy, teaching efficacy, and value beliefs. This study shows that Turkish preschool teachers similarly hold complex belief structures about their efficacy and motivation for teaching coding and CT. Similar findings are also noteworthy in the international literature. For example, studies conducted in different countries have reported that teachers generally have positive value beliefs about coding instruction, but that they experience a lack of technical knowledge and low self-efficacy in applying it to practice (Angeli et al., 2016; Aranda & Ferguson, 2018; Yadav et al., 2018).

Rich et al. (2021) revealed that self-efficacy beliefs towards coding and CT are related but separate constructions. The CFA results of our study also showed that the discrimination power between these constructions was high and that teachers evaluated these two concepts separately. As a matter of fact, although teachers understand the importance of CT, it is thought that their self-efficacy for teaching may be low (Rich et al., 2021). In this context, it is suggested that in-service training programs should include interventions specific to these two belief dimensions. In addition, both in the original study and in this adaptation study, teaching efficacy was emphasized.

When reviewing the literature, it is observed that measurement tools developed for coding and CT concepts are generally created separately and are mostly prepared for primary or secondary school students and teacher candidates (Gülbahar et al., 2018; Karaman & Büyükalan Filiz, 2019; Korkmaz et al., 2015, 2017; Kukul et al., 2017; Özçınar & Öztürk, 2018; Üzümcü, 2023). However, there is no comprehensive tool that aims to measure preschool teachers' competencies, skills, attitudes, or beliefs in these areas.

This situation creates a significant gap in terms of assessing the readiness levels of teachers working in early childhood education with regard to these skills. In this context, the TBaCCT scale offers a comprehensive structure with the potential to fill this gap. The findings reveal that the factor structure of the scale adapted into Turkish largely corresponds to the original form and provides a valid tool for assessing teachers' beliefs. Therefore, the scale has theoretical consistency that can be used to measure coding and CT-related beliefs not only in the Turkish context but also in different cultural environments.

As stated by Tschannen-Moran and Hoy (2001), teachers' beliefs about their teaching efficacy directly affect not only classroom behaviors but also students' achievement, motivation and participation levels. This situation is thought to reinforce the necessity of evaluating the teaching efficacy dimension of coding and CT teaching separately. Longitudinal analyses conducted by Rich et al. (2021) revealed that teachers showed statistically significant improvements in self-efficacy and teaching efficacy over time. Although our study had a cross-sectional design, we conclude that structured in-service training programs can have similar positive effects for preschool teachers. This adaptation study not only provides a culturally valid instrument but also demonstrates the applicability and validity of the TBaCCT scale in different contexts. As coding and CT are becoming an essential component of 21st century education (Wing, 2006), it is of great importance to support preschool teachers' readiness to integrate this content into their classrooms. This adapted scale can be used to identify gaps in teacher beliefs and contribute to the development of targeted interventions and curricula.

In conclusion, this study fills an important gap by providing a powerful measurement tool for the Turkish preschool context. The findings indicate that the TBaCCT scale is a valid and reliable instrument for assessing preschool teachers' beliefs about coding and CT. In line with Rich et al. (2021), this study emphasizes that teacher education programs should be structured to develop not only technical skills but also positive values and self-efficacy beliefs. In future studies, it is recommended to apply the scale with different regions and samples and to monitor changes in teacher beliefs longitudinally. Thus, the complex structures of beliefs about coding and CT teaching in early childhood can be understood in more depth.

Limitations

The study has some limitations. One of the most important shortcomings of the current study is related to the sampling method used, as the convenience sampling method limits the generalizability of the findings. The sample is limited to 201 preschool teachers in Türkiye who voluntarily participated in the study. Therefore, the generalizability of the findings may be limited. Further studies with larger samples from different regions and with different demographic characteristics may further strengthen the construct validity and reliability of the scale. Secondly, only the self-report-based questionnaire method was used in the data collection process which may create social desirability bias in the participants' responses. Third, criterion validity analysis was not included in the study; that is, the validity of the scale was not tested by comparing it with another similar measurement tool. In addition, some reliability analyses, such as test-retest reliability, were not conducted. In this respect, considering the limitations of the study, it is recommended that these deficiencies be addressed in future studies.

Statements of Publication Ethics

Ethical approval for this study was obtained from the Ethics Committee of Hacettepe University (Decision No: E-358531772-300-00001632702, Date: 20.05.2021).

Researchers' Contribution Rate

Authors	Literature review	Method	Data Collection	Data Analysis	Results	Conclusion
Author 1	☒	☒	☒	☒	☒	☒
Author 2	☒	☒	☐	☒	☒	☒

Conflict of Interest

The research was not financially supported by an organization/project. No conflict of interest.

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