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A validity and reliability study of the Turkish computational thinking scale

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Highlights

- Confirmatory factor analysis was used to assess the scale's factor validity, and the results showed that the scale had a good match.
- With the use of Turkish version of CTS developed, the conceptual framework of the CT process was validated with five factors.
- CT is a skill that has common aspects for computer science as well as for other scientific disciplines such as mathematics.

Article Info: Research Article

Keywords: *Computational thinking, Scale adaptation, Validity, Reliability*

Abstract

The purpose of this study was to adapt the computational thinking scale developed by Tsai, Liang and Hsu (2021) into Turkish in order to determine the computational thinking skill levels of secondary school students according to such basic elements defined by Selby and Woollard (2013) as abstraction, decomposition, algorithmic thinking, evaluation and generalization and to do the related validity and reliability study. A total of 454 high school students (9^{th} – 12^{th} grade) determined with the convenient sampling method constituted the sample of the study. The original scale was made up of 19 5-point Likert-type items. Confirmatory Factor Analysis (CFA) was performed to examine the conformity of the data collected via the adapted scale to the five-factor structure of the original scale. As a result of CFA, it was seen that the factor structure of the original scale was preserved. The reliability of the scale was checked with the internal consistency coefficient for the whole scale and its factors. The Cronbach Alpha coefficients obtained were .84 and McDonald's omega coefficients obtained were .86. The scale's Turkish adaptation was found to be a valid and trustworthy measurement tool for establishing the computational thinking proficiency levels of students in high school.

1. Introduction

Today's digital natives need a number of skills to overcome the difficulties they face in learning and teaching environments with the computers they need in their daily lives. For this reason, computer literacy has emerged as a necessity for students, who are digital natives of the 21^{st} century, just like being literate (Fraillon et.al., 2019; Tsai, 1999). Computer literacy refers to the skills considered necessary to conduct research, produce products and communicate in business life and learning-teaching environments with computers that individuals need in their daily lives (Fraillon et.al., 2019). A new set of dimensions of computer literacy emerged in terms of the needed environments and capabilities. One of these is the Computational Thinking (CT) dimension put forward by computer scientists (Wing, 2006, Wing, 2011). The CT dimension has attracted the attention of many different fields. In relation to this, CT skill emerges as a skill that not only the individuals in the fields of computer science, engineering, mathematics and so on but also almost all the other individuals of our age have a close interest in (Wing, 2006). The fact that the CT skill has drawn attention in many fields has led to the emergence of different definitions and evaluations about this concept. However, according to studies on CT skills conducted in recent years, there are some uncertainties about the related definitions and evaluation tools (Grover and Pea, 2013;

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Tang et.al., 2020). Determining a coherent conceptual framework and a credible and trustworthy assessment tool is therefore important before incorporating the CT skills into the learning areas.

Early studies on computational thinking are summarized in Figure 1.

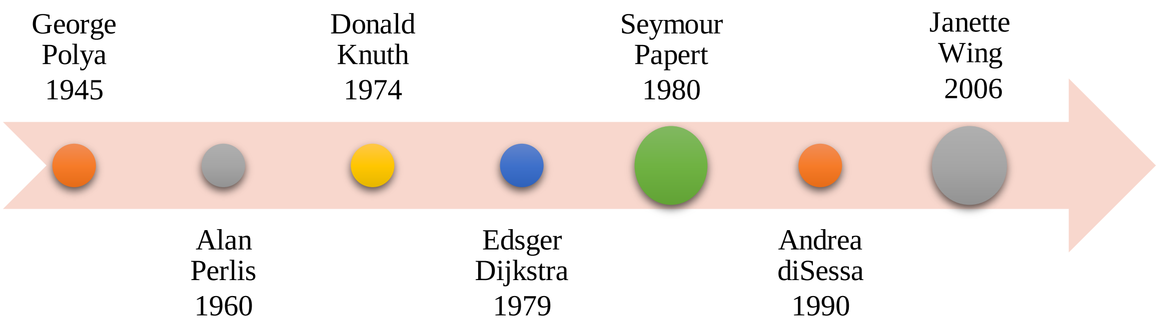

Figure 1. Early studies on computational thinking

Polya (1945) was the forerunner of CT in his work "How to solve", which was about the mental disciplines and methods that make it possible to solve mathematical problems. Perlis (1960), arguing that the concept of "algorithm" was already part of our culture, pointed out that computers would automate and eventually transform processes in all domains and that the algorithm would ultimately emerge in all domains. Knuth (1974) stated that expressing an algorithm (to a stupid machine) was a form of teaching that leads to a deep understanding of a problem. Dijkstra (1979) noted the importance of computational habits learned to assist good programming. Seymour Papert's research at MIT in the 1980s is where the concept of teaching computing and programming to every student in K12 education first emerged (Barendsen et al., 2015; Grover and Pea, 2013). The Logo programming language was created by Papert in 1980 with the express purpose of introducing computing and programming to schoolchildren of all ages. The diSessa (1991) study provides another significant understanding of computational thinking. As a result of his experiences with Logo, diSessa (1991) created a different programming environment called Boxer to advance "computational literacy" in K12 settings (Sherin et.al., 1993). For the first time in 2006, Jeannette Wing introduced the concept of CT, whose original name was Computational Thinking. Wing (2006) stated that every child should adapt CT to their analytical skills for reading, writing and arithmetic.

Definition and Dimensions of Computational Thinking

Wing (2006) defined CT as a 21st century skill which “involves problem solving, designing systems, and understanding human behavior with the use of fundamental concepts for computer science” (p 34). It is seen that many researchers have made definitions of CT. Denning (2009) defined CT as "thinking with many levels of abstraction, using mathematics to develop algorithms, and examining how well a solution is scaled on problems of different sizes." According to Lu and Fletcher (2009), CT is about "learning all the mental tools necessary to apply computing effectively to address difficult human problems," not about thinking like a machine. Brennan and Resnick (2012) stated that CT helped us think about learning with Scratch and that programming with Scratch contributed to the acquisition of CT skills.

In addition to defining CT, researchers also carried out investigations to pinpoint important notions and procedures associated with CT. While some academics concentrated on identifying CT applications in certain professions, such computer science, others aimed to give a more thorough output of these applications to be used across disciplines. Wing (2006) proposed that CT incorporate recursive thinking, use of abstraction and decomposition when addressing a complicated problem, and evaluation of the answer for both efficiency and aesthetically. This suggestion was made from the perspective of a problem-solving talent in computer science. In relation to this, Denning (2009) thought that CT involves "thinking with many levels of abstraction, using mathematics to develop algorithms, and examining how well a solution is scaled on problems of different sizes". Grover and Pea (2013) revealed that abstraction is the cornerstone of CT and is a feature distinguishing CT from other types of thinking.

When the sub-dimensions of the CT process are considered in the context of the problem-solving steps, Selby and Woollard (2013) thought the sub-dimensions were five basic elements named as abstraction, decomposition, algorithmic thinking, evaluation and generalization. Problem-solving steps of the mental processes of these five basic elements: (1) abstraction describes the mental process of concentrating on key information instead of details when solving an issue; (2) decomposition is the mental act of breaking problems down into manageable pieces in order to solve them; (3) algorithmic thinking, which illustrates the thought process used to develop a solution with detailed instructions; (4) evaluation is a mental process that demonstrates comparing different alternatives and choosing the best one by taking resources into consideration; and (5) generalization is the mental process of extending a solution model to other situations that are similar to the one at hand and seeing patterns in how to solve the problem at hand (Selby & Woollard, 2013).

Recently, many researchers have discussed CT with the sub-dimensions of algorithmic thinking, social cooperation, creative thinking, and critical thinking (Doleck et al., 2017). In fact, Allsop (2019) stated that CT should go beyond the problem-solving steps and be organized with a higher level of skill (Doleck et.al., 2017). As a result, the consistent views of the cognitive processes of problem-solving steps in learning environments turned into a tool for defining and evaluating computational thinking by creating a conceptual framework for the five elements defined by Selby and Woollard (2013).

Applying mathematical knowledge to solve equations and functions is a key component of mathematical thinking (Sneider et al., 2014). Beliefs in mathematics, problem-solving techniques, and justifications for solutions make up the three components of mathematical thinking. Problem solving methods are the key similarity between CT and mathematical thinking (Wing, 2008). Computer science, as well as other scientific fields like mathematics, share some characteristics with CT. Considering both computational thinking and mathematical thinking, both could be said to act from a perspective that uses the concepts of cognition, metacognition, and dispositions, which are at the center of problem solving.

Constantly updated computer technologies require updating the definition of computer literacy. For example, with the development of artificial intelligence technology, the change in the lifestyles of individuals is based on the approach of systematically thinking like a computer scientist while solving complex problems and producing solutions to problems. In this respect, CT be a new dimension of computer literacy that should be integrated with learning areas of educational environments (Wing, 2006, Wing, 2010). In recent years, the promotion of CT in educational environments has increased the interest (Kong et al., 2019; Yadav et al., 2014). In addition, involving CT in educational environments can act as a bridge not only to STEM education, but also between the learning environment and professional practices (Weintrop et al., 2016). Studies related to the integration process of CT into learning areas were carried out, and as a result, different definitions and assessment tools were obtained. Previous studies can be considered in two dimensions in the conceptual framework. First, CT is field-specific and defined by the field name. The second dimension is the evaluation of CT as a learning outcome or learning process. If we need to categorize these dimensions conceptually, we can divide them into two categories: one is a field-specific category, and the other is a field-general category (Tsai et.al., 2021). Field-specific category: Although many misunderstandings have been addressed (Wing, 2006) to clarify the idea that CT is not the same as computer programming (Wing, 2006), definitions belonging to the field of computer programming have been adopted to express CT in many studies (Tang et al., 2020). For instance, in a study investigating the learners' processes of learning Scratch programming, CT was referred to as computational concepts, computational applications and computational perspectives (Brennan and Resnick; 2012). Since field-specific definitions are typically dependent on a particular popular programming language, such as Scratch, Python, or Java, they are easily altered over time and may cause the evaluation process to place more emphasis on lines of code than on thinking (Tsai et al., 2019). Field-general category: CT can be defined as the competencies of individuals that need to be done systematically to solve problems in their lives and learning areas (Tsai et al., 2019). For instance, several researchers discussed the notion that CT needs to be viewed as a thinking process (Guzdial, 2008) and that it can be integrated into other learning areas (Denning, 2007). It was defined broadly by Wing (2011) as “a thought process that involves transforming a complex problem into manageable parts, abstracting critical information, rethinking, and evaluating solutions to deal with the problem effectively and efficiently”.

Recent studies on CT in the form of process comparison with results have been evaluated as tests for programming skills, learning performances through conceptual tests and learning outcomes. Some of these studies are shown in Table 1.

Table 1.

Test development and adaptation studies related to CT

Researchers	Year	Purpose
Marcos Román-González, Juan-Carlos Pérez-González and Carmen Jiménez-Fernández (Román-González, Pérez-González, & Jiménez-Fernández, 2017).	2017	Prepared a test on the assessment of computational thinking with multiple-choice questions measuring students' computational concepts.
İbrahim Çetin, Tarık Otu and Asuman Oktaç (Çetin, Otu, &Oktaç,2020)	2020	This study aimed to translate the Spanish-developed computational thinking test into Turkish.
Francisco Bavera, Teresa Quintero, Marcela Daniele, Flavia Buffarini and C. De Dominici (Bavera, Daniele, Buffarini, Quintero & De Dominici, 2020).	2020	In this study, the computational thinking abilities of primary school teachers pursuing a computer science specialization were assessed by the examination of an experience based on a few Bebras tasks.

The above-mentioned studies evaluated CT with performance and tests regarded as field-specific and field-general in terms of the results and as field-general in terms of thinking processes.

Survey data can provide perception or self-reflection, especially about some high-level skills that are not easily observed or about subjective experiences in the thinking process (Tsai et al., 2021). For this purpose, the scales used to examine the relationship between computational thinking and other variables by using large samples will be useful. In this respect, more studies could be conducted to develop valid and reliable scales so that CT can be measured more effectively (İliç et al., 2018). Recently, some studies have addressed high-level skills or competencies that cannot be easily observed or measured in the context of scale development and validation studies to evaluate computational thinking (Tsai et al., 2021).

Table 2.

Scale development and adaptation studies related to CT

Researchers	Year	Purpose	CT Dimensions of the Scale
Özgen Korkmaz, Recep Çakır and M. Yaşar Özden (Korkmaz, Çakır, & Yaşar, 2017)	2017	Developing a scale to measure CT skills	• Solving, • Algorithmic thinking • Critical thinking, • Cooperative learning, • Creative thinking,
Mustafa Yağcı (Yağcı, 2019)	2019	Developing a scale to measure CT skills of high school students.	• Problem solving, • Cooperative learning, • Critical thinking, creative thinking and • Algorithmic thinking

Charinthorn Aumgri and Sirirat Petsangsri (Aumgri & Petsangsri, 2019)	2019	Developing a CT measurement tool for preservice teachers	• Problem solving, • Creating work pieces, • Determining the reasons analytically, • Designing countermeasures, • Conducting analysis and managing the data, • Evaluating the work pieces and working in cooperation
Volkan Kukul and Serçin Karataş (Kukul & Karataş, 2019)	2019	Developing a measurement tool to measure students' CT self-efficacy	• Reasoning, • Abstraction, • Decomposition and • Generalization,
Yasemin Gülbahar, Serhat Bahadır Kert and Filiz Kalelioğlu (Gülbahar Kert & Kalelioğlu, 2019)	2019	Developing the CT skill self-efficacy perception scale for secondary school students	• Designing an algorithm, • Problem solving, • Data processing, • Basic programming, • Self-confidence
Buket Ertugrul-Akyol (Ertugrul-Akyol, 2019)	2019	Developing a scale for CT	• Computational thinking, • Robotic coding and software, • Professional development and • Career planning
Ahmet Dolmacı and Nadire Emel Akhan (Dolmacı & Akhan, 2020)	2020	Developing a scale covering computational thinking skills for preservice teachers	• Algorithmic-analytical thinking, • Creative problem-solving, • Ability to cooperate, • Critical thinking and • Ability to use the computer,
Murat Ekici and Murat Çınar (Ekici & Çınar, 2020)	2020	The Turkish version of the Computer Programming Self-Efficacy Scale's validity and reliability study.	• Logical thinking, • Cooperation, • Algorithm, • Control, • Debugging,
Veysel Karani Ceylan (Ceylan, 2020)	2020	The effect of scenario-based scratch curriculum on students' computational thinking skills, problem solving and programming unit achievements	• Algorithmic thinking, • Decomposition, • Parallelization, • Abstraction • Automat
Halit Karalar and Muhammet Mustafa Alpaslan (Karalar & Alpaslan, 2021)	2021	Assessment of Eighth Grade Students' Domain-General Computational Thinking Skills	• Abstraction, • Decomposition, • Algorithmic thinking, • Evaluation, • Generalization

As a result, all the computational thinking scales mentioned in Table 2 were field-specific; therefore, several dimensions or factors were overlooked in these studies. There is a need to develop a field-general process-oriented computational thinking scale. Since field-specific definitions are usually tied to a particular popular programming language such as Scratch, Python or Java, they can be easily changed over time and may lead to focusing on lines of code rather than thinking in the evaluation process (Tsai et al., 2019). Depending on these learnings, we can call it result-oriented assessment scales field-specific. On the other hand, the field-general category can be defined as the competencies of individuals that need to be done systematically to solve problems in their lives and learning areas (Tsai et al., 2019). Depending on these learnings, we can call it result-oriented assessment scales field-general. Here, the original scale field-specific and field-general assessment scales are presented with a process-oriented theoretical framework based on problem-solving steps by Selby and Woollard (2013). In addition, it was stated in the original study that the scale could be used for different disciplines as process-oriented and field-general. Our study, on the other hand, was presented by Selby and Woollard (2013) with a theoretical framework based on problem-solving steps, with a process-oriented field-general assessment scale. During the implementation of this scale, it was presented with the explanation of "when I solve a problem in mathematics ...".

Mathematical thinking involves applying mathematical skills to solve mathematical problems such as equations and functions (Sneider et al., 2014). The main common point between CT and mathematical thinking is problem solving processes (Wing, 2008). CT is a skill that has commonalities for computer science as well as other scientific disciplines such as mathematics. For this reason, some researchers have shared their thoughts that CT should be seen as a thinking process (Guzdial, 2008) and that it can be integrated into other learning areas (Denning, 2007). Wing (2011) defines CT field- general as “a thought process that involves turning a complex problem into manageable parts, abstracting critical information, thinking it through, and evaluating solutions to deal with the problem effectively and efficiently”. CT related scale development and adaptation studies in research are often field-specific. However, the original scale states that there is a need for a field-general assessment tool. In this study, it is thought that field-general measurement tool will be adapted to the Turkish literature. In addition, while the questions about the scale items of the Turkish version of the CT scale were asked to the students, in the explanation section, “1. While answering the questions, you can visualize that you are solving a mathematical problem and answer accordingly. 2. For example, when I solve a problem in Mathematics, start with the statement …, answer the questions about the scale items” and it is aimed to bring a field-general process-oriented assessment tool to the literature in the context of problem solving processes, which is the common point between CT and mathematical thinking.

When the literature was reviewed, a CT scale consisting of 19 items developed by Tsai et al. (2021) as a field-general scale was reached. The developer confirmed the developmental model of computational thinking by confirming the structural relationships between the five factors of the computational thinking scale (Tsai et al. 2022). Tsai et al. (2021), for the purpose of measuring the CT skill, developed and validated a field-general, process-oriented scale based on the five basic elements of the process (abstraction, decomposition, algorithmic thinking, evaluation and generalization) put forward by Selby and Woollard (2013). Researchers may need a field-general scale to evaluate the results of research on the development of CT. As the studies on CT are few in number, there is a need for a field-general Turkish standard measurement tool. The purpose of this study was to adopt the computational thinking scale into Turkish which was developed in English by Tsai et al. (2021) and whose validity and reliability studies were conducted.

2. Methodology

2.1. Sample

The sample of this study consisted of 9th grade to 12th grade of a district in the Aegean Region students. A total of 454 students (198 female and 256 male) who were selected using the convenient sampling method constituted the research sample (Table 3). The students forming the sample; Anatolian Imam Hatip High School has 249 students, Anatolian high school’s 97 students, Science and Social Sciences high school’s 86 students, Vocational and Technical Anatolian high school’s 28 students. The district in the study was chosen as a city that the researcher could easily reach. The original scale was developed for 8th grade and 9th grade students in a suburban area in northern Taiwan. In the Taiwan education system, the secondary school education period is 3 years and covers the 7th, 8th and 9th grades. The grade levels in the original scale correspond to the levels of students whose 8th grade is middle school and 9th grade is high school under the conditions of our country. Acquiring and developing problem solving and computational thinking skills are included in the special objectives of the computer science course, which is taught as an elective or common course in the weekly course schedule of secondary education institutions in our country. In this context, it was decided to apply the scale at the 9th, 10th, 11th and 12th grade levels by taking expert opinion, with the thought that The Turkish form appropriateness would be ensured. In this study, the scale for grades 9 to 12 was adapted to Turkish.

Table 3.

Class grade and gender of the students who constituted the study group

Class Grade	Female	Male	Total
9th grade	48	60	109
10th grade	56	69	125
11th grade	41	58	99
12th grade	53	69	124
Total	198	256	454

2.2. The Original Measurement Tool

The computational thinking scale, which aimed to measure students' thinking processes regarding CT, was developed by Tsai et al. (2021) according to such dimensions suggested by Selby and Woollard (2013) as abstraction, decomposition, algorithmic thinking, evaluation and generalization. The scale consisted of 19 a 5-point Likert-type items, rated between “Strongly agree (5)” and “Strongly disagree (1)”. The scale produced scores ranging between 19 and 95. The scale was made up of five sub-dimensions: abstraction, decomposition, algorithmic thinking, evaluation and generalization. Items 1, 2, 3 and 4 represented the factor of abstraction; Items 5, 6 and 7 the factor of decomposition; Items 8, 9, 10 and 11 the factor of algorithmic thinking; items 12,13,14, and 15 the factor of evaluation; and the items 16, 17, 18 and 19 represented the factor of generalization. The internal consistency coefficients of the factors constituting the scale were α=.81 for abstraction; α=.74 for decomposition; α=.77 for algorithmic thinking; α=.83 for evaluation and α=.75 for generalization.

2.3. Adaptation of the Scale to Turkish and the Application

Permission to adapt the scale was obtained by communicating with the researchers who developed the scale. The first step in the adaptation process was to translate the scale from English to Turkish. There are four different methods that can be used when translating a measurement tool from the source language to the target language: judgmental single translation, judgmental back-translation, single-translation based on statistical analyses, and back-translation based on statistical analyses (Hambleton & Bollwark, 1991). In this study, a judgmental single translation method based on the principle that one or more translators translate the scale from the source language to the target language, then another group compares the original form with the translated form and decides whether the two forms are linguistically equivalent and makes changes in the translated form if they consider it necessary (Hambleton & Kanjee, 1993). In this respect, the scale items were translated from English to Turkish by an English teacher with 16 years of seniority and from Turkish to English by an English teacher with a seniority of 17 years. The translations from Turkish to English and from English to Turkish made by two teachers were brought together, and the Turkish expressions that best reflected the relevant item were determined for each item. The Turkish version, which was created to ensure language validity, was presented one professor and the other associate professor to two different experts together with the original form of the scale, and the experts were asked to examine whether the two versions were equivalent to each other. The corrections from the experts were re-evaluated by the researchers, and the necessary changes were made, finalizing the Turkish equivalents of the scale items. This evaluation was determined by the Kappa coefficient, which is one of the methods used to provide evidence for the reliability of the inter-expert agreement. The Kappa coefficient is used to determine the level of agreement between the scale items of the two experts and takes into account the agreement rate in each criterion. Since the Kappa coefficient also takes into account the harmony formed by chance, it gives more accurate information than the simple percent harmony calculations (Kutlu, Doğan & Karakaya, 2014: 84). Kappa coefficients are interpreted as <.20 weak agreement, between .20 - 40 acceptable, between .40 - .60 moderate agreement, between .60 - .80 good agreement, between .80 - 1.00 very good agreement (Şencan, 2005). In this study, two different experts were asked to read the items of a scale consisting of 19 questions and to express their opinions with the options "appropriate or not appropriate". Kappa coefficient for the level of agreement between experts was calculated as 0.61. Inter-expert agreement showed good agreement in the translation of scale items. At the same time, an expert in Turkish Language was asked for his/her opinions about the suitability of the scale. The Turkish version of the scale was developed as a 5-point Likert-type scale, and as in the original version, the items were graded between "Strongly Agree (5)" and "Strongly Disagree (1)". In order to get feedback on the clarity of the translations, opinions about the scale were received from three teachers who were taking their doctoral education in the field of secondary school mathematics education. The Turkish version (Appendix 1) of the Computational Thinking Scale (CTS) was created with the opinions of the three teachers who reported that the scale items were clear and understandable. After the intelligibility of the items was tested on three mathematics teachers who were PhD students, the scale was made ready for application by obtaining permission from the ethics committee.

In the original article, Tsa et al. (2021) talks about being able to determine a general question title in a way to cover all the items of the scale, taking the problem-solving processes into account. For example, a basic item such as "When I solve a problem with computer programming, ..." indicates a process of solving a problem using computer programming. The fundamental question for the math learning process would be “When I solve a math problem, ...”. This basic question also indicates a problem-solving process using Mathematics. It is not necessary to specify the field which the question determined for a field-general category belonged to; therefore, it could be simplified to "When I solve a problem, ..." For this reason, as suggested in the study conducted by Tsai et al. (2021), the participants were asked to respond to the items of the scale by considering the general title of "When solving a Mathematics problem..." in a process-oriented manner. CTS can be used in all problem-solving processes by changing the basic question at the top of the scale.

2.4. Data Analysis

The process shown in Figure 2 was followed in the analysis of the collected data.

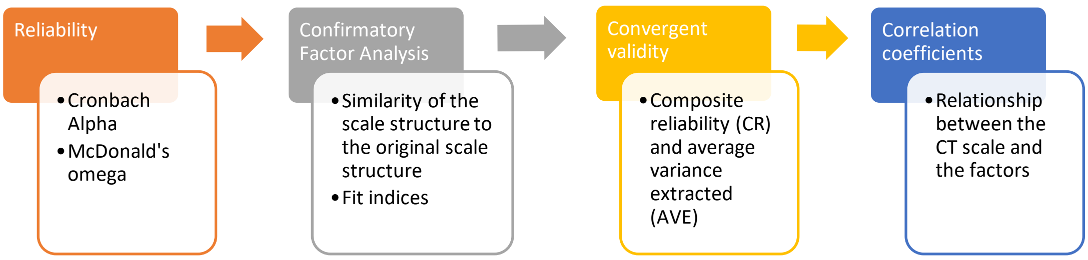

Figure 1. The steps followed in the scale adaptation process

By computing the Cronbach Alpha and McDonald's omega internal consistency coefficients for each of the scale's sub-dimensions separately, the reliability of the scale was examined. The data obtained from the sample were subjected to CFA to determine the similarity of the structure of the scale with that of the original scale. In scale adaptation studies, the use of confirmatory factor analysis looks more appropriate as the original scale has a certain factor structure (Fabrigar et al., 1999; Gözüm and Aksayan, 2003; Güngör, 2016). In addition, the chi-square value and the degree of freedom are affected together with the growing sample in the interpretation of the CFA result in large samples, which may lead to misinterpretations (Çokluk et.al., 2012). For this reason, in the interpretation of the CFA result, the fit indices of CFI, NFI, NNFI, RFI, IFI, RMSEA, SRMR were used instead of the division of the chi-square value by the degree of freedom. RMSEA (Root Mean Square Error of Approximation), SRMR (Standardized Root Mean Square Residual), CFI (Comparative Fit Index), RFI (Relative Fit Index), IFI (Incremental Fit Index), NFI (Normed Fit Index), non-normed fit index in LISREL and NNFI-TLI fit indices in AMOS as Tucker Lewis Index were included.

2.5. Findings Regarding the Scale's Reliability

When the normality of the data for the Turkish form was examined, it was seen that the skewness and kurtosis values were between ± 1.5 and it was understood that it had a normal distribution. In order to determine the reliability of the scale, the internal consistency coefficient Cronbach's alpha and McDonald's omega values were calculated. Cronbach's alpha coefficient was calculated as α =.85 and McDonald's omega coefficient as ω=.86. In the evaluation phase of Cronbach's Alpha (α) and McDonald's Omega (ω) values - also known as construct reliability (Nunnally & Bernstein, 1994) - McDonald's Omega (ω) coefficient was taken as basis. For comparison purposes, both Cronbach's Alpha (α) and McDonald's Omega (ω) values were calculated together. Cronbach's Alpha (α) McDonald's Omega (ω) internal consistency coefficients for CTS are given in Table 4

Table 4. Cronbach Alpha and McDonald’s Omega internal consistency coefficients for the factors

Factors	Number of Items	Reliability Coefficient for the Original Scale (α)	Reliability Coefficient (α)	McDonald’s Omega (ω)
Abstraction	4	.83	.73	.81
Decomposition	3	.81	.73	.85
Algorithmic Thinking	4	.74	.77	.82
Evaluation	4	.75	.83	.86
Generalization	4	.77	.73	.73

As seen in Table 4, Cronbach's Alpha (α) values for the Abstraction, Decomposition, Algorithmic Thinking, Evaluation and Generalization subscales are over .70 and McDonald's Omega (ω) values are over .80. McDonald's Omega (ω) values for sub-dimensions vary between .73 and .86. Based on both calculated coefficients, the Turkish version of Computational Thinking Scale (Turkish version of CTS) can be said that the overall scale and subscales are reliable.

2.6. Findings Regarding the Confirmatory Factor Analysis

Standardized CFA of Item-Structure Relationships of Turkish version of CTS

In order to determine the compatibility of the Turkish version of the scale with the original scale's factor structure, CFA was performed using the Amos 24 package program. The findings obtained from CFA proved that the Turkish scale had the same five factors as the original scale. When the modification indices of the items were examined, it was seen that there was a high level of covariance between the items e9 - e10, e13 - e15, e17 - e18 and that the error terms of these items were combined and modified. When the modified items are examined in general, it is seen that items e9 and e10 are items belonging to the algorithmic thinking subscale, items e13 and e15 are items belonging to the evaluation subscale, and items e17 and e18 are items belonging to the generalization subscale. It is seen that the items "I usually try to find effective solutions for a problem", which is the 9th item, and "I usually try to organize the steps of a solution", which is the 10th item, measure a common variable in finding and organizing the solution of the problem. It is seen that the 13th item "I usually think of the best solution for a program" and the 15th item "I usually think of the fastest solution for a problem" measure a common variable in terms of being fast while finding the best solution. It is seen that the 17th item "I usually try to use a common way to solve different problems" and the 18th item "I usually think about how to apply a solution to other problems" measure a common variable at the point of choosing the way to be used to solve the problem. In the modifications made, it is seen that the items that have a common variable variance and that are linked to each other can be explained theoretically. Since these items belong to the same subscales and therefore tend to measure similar characteristics, modifications were made between the items in question (Figure 3). In the visual in Figure 3, abstraction was shown as (A), decomposition (D), algorithmic thinking as (AT), evaluation as (E), and generalization as (G).

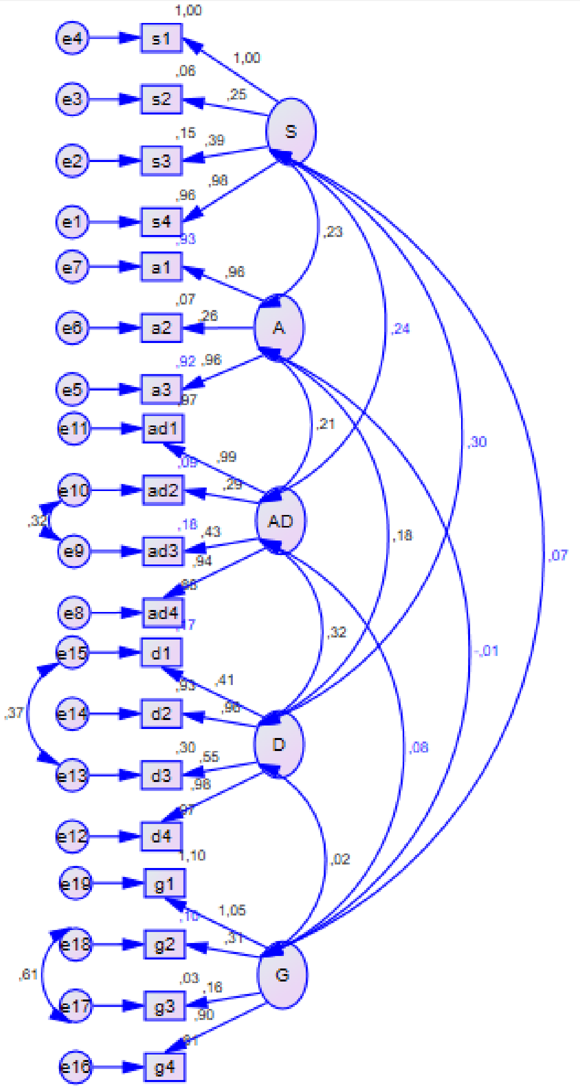

Figure 2. Fit index values obtained as a result of CFA belonging to CTS

On the other hand, the fact that the RMSEA value is equal to .08 indicates that the scale has an acceptable fit (Brown, 2006). In addition, the fact that the NNFI value is .93, the CFI value is .94, the IFI value is .94, the RFI value is .91 and the NFI value is .92 indicates that the scale has reached an acceptable fit (Byrne, 1998; Hu and Bentler, 1999). The fact that the SRMR value is .10 indicates that the scale has an acceptable fit (Brown, 2006). The fit index values obtained as a result of CFA of Turkish version of CTS and the fit levels accepted in the literature are given in Table 5.

Table 5. The fit index values accepted, and values obtained as a result of CFA

Fit Indices	Values Obtained	Accepted Fit Levels
RMSEA	.08	≤ **.08**
CFI	.94	≥ .90
IFI	.94	≥ .90
RFI	.91	≥ .90
NNFI	.93	≥ .90
NFI	.92	≥ .90
SRMR	.10	≤ .10

2.7. Convergent validity

Convergent validity study should be done in order to reveal the construct validity of the scale in the analysis of the research. Convergent validity is a concept that expresses the relationship between the expressions in the variables and the factors they have created (Coşkun et al., 2010). Composite reliability (CR) and average variance extracted (AVE) values were calculated to ensure convergent validity. To ensure convergent validity, CR>AVE; AVE should be >0.5. It is stated that an AVE value above .50 is acceptable (Fornell and Larcker, 1981). The CR and AVE values calculated for each of the subscales are given in Table 6.

Table 6. Average Variance Extracted (AVE), Composite Reliability (CR) values

Factors	Number of Items	Composite reliability (CR)	Average Variance Extracted (AVE)
Abstraction	4	.78	.54
Decomposition	3	.94	.68
Algorithmic Thinking	4	.78	.53
Evaluation	4	.83	.59
Generalization	4	.74	.51

When the convergent validity is evaluated, it is seen that the CR values are above .70. Like the Cronbach Alpha, a CR above .70 provides additional empirical evidence for the reliability of the scale (Raykov, 1998). However, it was determined that all CR values for the factors were greater than the AVE values. In addition, the AVE value of the Abstraction, Decomposition, Algorithmic Thinking, Evaluation and Generalization sub-dimensions was found to be above the critical value of .50. Based on the research findings, it can be stated that convergent validity was achieved.

2.8. Correlation coefficients between Turkish version of CTS and the sub-factors

To find out how Turkish version of CTS and the five components that made up the scale related to one another, correlation coefficients were determined. The correlation coefficients between Turkish version of CTS and the sub-factors are shown in Table 7.

Table 7. Correlation coefficients between Turkish version of CTS, CTS and the sub-factors

	Abstraction	Decomposition	Algorithmic Thinking	Evaluation	Generalization
Turkish version of CTS	.70*	.61*	.74*	.74*	.45*
CTS	.81	.74	.77	.83	.75

**p<.01*

As seen in the table, the variables and the entire scale have correlation values between .45 and .74, indicating a strong and positive relationship.

3. Discussion and Conclusion

Turkish adaptation of CTS, which was created to assess secondary school students' CT proficiency levels, were used in this study. Both the original scale and the adapted scale were five-point Likert-type scales and consisted of 19 items under five factors. These factors were abstraction, decomposition, algorithmic thinking, evaluation and generalization. The sample of this study, in which confirmatory factor analysis was conducted, included a total of 454 students (198 female and 256 male). The participants were 9th grade, 10th grade, 11th grade and 12th grade students. Confirmatory factor analysis was used to assess the scale's factor validity, and the results showed that the scale had a good match (RMSEA =.08, SRMR =.10, NNFI =.93, CFI =.94, IFI =.94, RFI =.91, NFI =.92). The data collected were used to validate the model.

The Cronbach Alpha internal consistency coefficients of the scale adapted to Turkish were calculated as .73 for the factor of abstraction, as .73 for the factor of decomposition, as .77 for the factor of algorithmic thinking, as .83 for the factor of evaluation and as .73 for the factor of generalization. For the entire scale, the Cronbach Alpha reliability coefficient was determined to be .84. The fact that the Cronbach Alpha internal consistency coefficient calculated in this study was above .70 indicated that the scale was reliable (Büyüköztürk, 2013; Nunnally and Bernstein, 1994). According to the core Selby and Woollard (2013) elements of abstraction, decomposition, algorithmic thinking, evaluation, and generalization, the findings demonstrated that the Turkish version of CTS was a valid and reliable tool to be used to assess the CT ability levels of secondary school students.

Previous researchers introduced various definitions and assessments (Brennan and Resnick, 2012; Roma´n-Gonza´lez et al., 2017; Yadav et al., 2014) and suggested the development of a valid and reliable assessment tool for future studies. Tang et al. (2020) stated that there is a two-dimensional conceptual framework whose definitions are field-specific, field-general, and whose evaluations included analysis based on the outcome and process. The scale obtained in this study was a field-general and process-oriented measurement tool in order to properly evaluate CT. With the use of Turkish version of CTS developed, the conceptual framework of the CT process was validated with five factors (abstraction, decomposition, algorithmic thinking, evaluation and generalization) suggested by Selby and Woollard (2013). In other words, five dimensions can be used to conceptualize and explain the cognitive process of CT.

Additionally, Turkish version of CTS can be used to evaluate students' daily routines, dispositions, or tendencies to employ broad CT tools in all problem-solving contexts rather than emphasizing computer programming abilities or specific applications of computer science principles. According to the findings obtained for the students who participated in block-based game development, there was an increase in the computational thinking sub-dimensions of problem solving, cooperation and critical thinking (Dikkartın Övez & Acar, 2022). So, regardless of whether computer programming activities are included, CT can be used with all secondary students in all learning environments. CT is a skill that has common aspects for computer science as well as for other scientific disciplines such as mathematics. For this reason, as suggested in a study by Tsai et al. (2021), while answering the scale items, the participants could imagine the situation as "While solving a Mathematics problem, ...", and the CT scale could be used in all problem-solving processes by changing the basic question at the top.

Under the perspective of the curricula of the secondary education mathematics curriculum, students can learn at both national and international levels; Competencies, which are the skill ranges that they will need in their personal, social, academic, and business lives, have been determined as Turkey's qualifications framework (MEB, 2018). One of them is mathematical competence and basic competences in science/technology. This competency indicates the strength of the study in adapting a general process-oriented assessment tool to the field between mathematical thinking and CT to Turkish form of the scale. It is thought that it will contribute to the other context. In the application phase of this scale, the explanation of "when I solve a problem in mathematics ..." is important in terms of applying the scale to the field in a general process-oriented manner in different disciplines by ensuring the validity and reliability of the scale. In our country, the acquisition and development of problem solving and computational thinking skills are included in the special objectives of the computer science course, which is taught as an elective or common course in the weekly course schedule of secondary education institutions (MEB TTK, 2018). In this context, ensuring the Turkish form appropriateness of the scale at the 9th, 10th, 11th and 12th grade levels may be one of the weaknesses of the study compared to other studies. In addition, providing the Turkish form of the scale in a certain number of school types in the city where the research was conducted may be another weakness of the study. For the language translation of the Turkish form of the scale, the translation made by two linguists was done with a limited number of experts. Therefore, it weakens the study in terms of reducing the error rate of the translation and discussing different suggestions.

For future research, it is expected that the CT scale will contribute to the evaluation of students' perceptions of their problem-solving competencies and thus to obtain multidimensional inferences about instructional practices. The scale can also be applied to integrated interdisciplinary curricula such as Science, Technology, Engineering, Arts, Mathematics (STEAM) education. In future studies, it is recommended to examine the relationships between students' CT scale and various variables such as gender, branch, grade level, programming experience.

References

Allsop, Y. (2019). Assessing computational thinking process using a multiple evaluation approach. *International Journal of Child-Computer Interaction*, 19, 30–55. https://doi. org/10.1016/j.ijcci.2018.10.004

Aumgri, C., & Petsangsri, S. (2019). Computational thinking for preservice teachers in Thailand. A confirmatory factor analysis. *Revista ESPACIOS, 40(29).*

Barendsen, E., Mannila, L., Demo, B., Grgurina, N., Izu, C., Mirolo, C., ... & Stupurienė, G. (2015). Concepts in K-9 computer science education. *In Proceedings of the 2015 ITiCSE on working group reports* (pp. 85-116).

Bavera, F., Daniele, M., Buffarini, F., Quintero, T., & De Dominici, C. (2020). Didáctica de las ciencias de la computación: experiencias y percepciones de docentes de educación primaria. In *XXVI Congreso Argentino de Ciencias de la Computación (CACIC)(Modalidad virtual, 5 al 9 de octubre de 2020).*

Brennan, K., & Resnick, M. (2012). New frameworks for studying and assessing the development of computational thinking. *In Annual American Educational Research Association Meeting*, Vancouver, BC, Canada.

Brown, T.A. (2006). Confirmatory factor analysis for applied research. New York: *Guilford Press*

Büyüköztürk, Ş. (2013). Sosyal Bilimler için Veri Analizi El Kitabı İstatistik, Araştırma Deseni SPSS Uygulamaları ve Yorum. *Ankara: PegemA Yayıncılık, Genişletilmiş* 18. Baskı, Ankara.

Byrne, B. M. (1998). Structural equation modeling with LISREL, PRELIS, and SIMPLIS: Basic concepts, applications, and programming.

Ceylan, V. K. (2020). *Senaryo temelli scratch öğretim programının öğrencilerin bilgi işlemsel düşünme becerilerine, problem çözme ve programlama ünitesi erişilerine etkisi*. Doktora tezi, Aydın Adnan Menderes Üniversitesi Sosyal Bilimler Enstitüsü, Aydın.

Coşkun R, Altunışık R, Yıldırım E, Bayraktaroğlu S. (2010). Sosyal Bilimlerde Araştırma Yöntemleri SPSS Uygulamaları. Sakarya: *Sakarya Yayıncılık.*

Çetin, İ., Otu, T., & Oktaç, A. (2020). Adaption of the Computational Thinking Test into Turkish. *Turkish Journal of Computer and Mathematics Education (TURCOMAT), 11*(2), 343-360.

Çokluk, Ö., Şekercioğlu, G., & Büyüköztürk, Ş. (2012). *Sosyal bilimler için çok değişkenli istatistik: SPSS ve LISREL uygulamaları* (Vol. 2). Ankara: Pegem Akademi.

Denning, P. J. (2007). Computing is a natural science. *Communications of ACM*, 50, 13–18

Denning, P. J. (2009). The profession of IT Beyond computational thinking. *Communications of the ACM*, 52(6), 28-30.

Dikkartın Övez, F.T. & Acar, İ. G. (2022). The effect of block-based game development activities on the geometry achievement, computational thinking skills and opinions of seventh-grade students. *Journal of Educational Technology & Online Learning*, 5(4), 1106-1121.

diSessa, A. A. (1991). An overview of Boxer. *Journal of Mathematical Behavior*, 10(1), 3- 15.

Doleck, T., Bazelais, P., Lemay, D. J., Saxena, A., & Basnet, R. B. (2017). Algorithmic thinking, cooperativity, creativity, critical thinking, and problem solving: Exploring the relationship between computational thinking skills and academic performance. *Journal of Computers in Education*, 4(4), 355–369. https://doi.org/10.1007/s40692-017-0090-9

Dolmacı, A., & Akhan, N. E. (2020). Bilişimsel Düşünme Becerileri Ölçeğinin Geliştirilmesi: Geçerlik ve Güvenirlik Çalışması. *Itobiad: Journal of the Human & Social Science Researches 9*(3).

Ertugrul-Akyol, B. (2019). Development of Computational Thinking Scale: Validity and Reliability Study. *International Journal of Educational Methodology, 5*(3), 421-432.

Fabrigar, L. R., Wegener, D. T., MacCallum, R. C., & Strahan, E. J. (1999). Evaluating the use of exploratory factor analysis in psychological research. *Psychological methods*, *4*(3), 272.

Fornell C, Larcker DF. (1981). Evaluating structural equation models with un observable variables and measurement error. *Journal of Marketing Research*, 18(1), 39-50

Fraillon, J., Ainley, J., Schulz, W., Duckworth, D., and Friedman, T. (2019). IEA international computer and information literacy study 2018 assessment framework (p. 74). Springer Nature.

Gözüm, S. ve Aksayan, S. (2003). Kültürlerarası ölçek uyarlaması için rehber II: psikometrik özellikler ve kültürlerarası karşılaştırma. *Hemşirelikte Araştırma Geliştirme Dergisi*, 5, 1-25

Grover, S., & Pea, R. (2013). Computational thinking in K–12: A review of the state of the field. *Educational researcher*, 42(1), 38-43.

Guzdial, M. (2008). Education: Paving the way for computational thinking. *Communications of ACM*, 51, 25–27. https://doi.org/10.1145/1378704.1378713

Güngör, D. (2016). Psikolojide Ölçme Araçlarının Geliştirilmesi ve Uyarlanması Kılavuzu. *Türk psikoloji yazıları*, 19(38), 104-112.

Gülbahar, Y., Kert, S. B., & Kalelioğlu, F. (2019). Bilgi işlemsel düşünme becerisine yönelik öz yeterlik algısı ölçeği: Geçerlik ve güvenirlik çalışması. *Turkish Journal of Computer and Mathematics Education (TURCOMAT), 10*(1), 1-29.

Hambleton, R. K., & Bollwark, J. (1991). Adapting Tests for Use in Different Cultures: Technical Issues and Methods.

Hambleton, R. K., & Kanjee, A. (1993). Enhancing the Validity of Cross-Cultural Studies: Improvements in Instrument Translation Methods.

Hsu, C. Y., Liang, J. C., & Tsai, M. J. (2020). Probing the structural relationships between teachers' beliefs about game-based teaching and their perceptions of technological pedagogical and content knowledge of games. *Technology, Pedagogy and Education*, *29*(3), 297-309.

Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural equation modeling: a multidisciplinary journal*, *6*(1), 1-55.

İliç¸, U., Haseski, H., & Tuğtekin, U. (2018). Publication trends over 10 years of computational thinking research. *Informatics in Education*, 18(2), 297

Karalar, H., & Alpaslan, M. M. (2021). Assessment of Eighth Grade Students' Domain-General Computational Thinking Skills. *International Journal of Computer Science Education in Schools*, 5(1), 35-47.

Kong, S.-C., Abelson, H., & Lai, M. (2019). Introduction to computational thinking education. In S.-C. Kong & H. Abelson (Eds.), *Computational thinking education* (pp. 1-10). Springer Singapore

Korkmaz, Ö., Çakir, R., & Özden, M. Y. (2017). A validity and reliability study of the computational thinking scales (CTS). *Computers in human behavior*, *72*, 558-569.

Kukul, V., & Karatas, S. (2019). Computational thinking self-efficacy scale: Development, validity and reliability. *Informatics in Education*, *18*(1), 151-164.

Kutlu, Ö., Doğan, C. D. & Karakaya, İ. (2014). Ölçme ve değerlendirme: performansa ve portfolyoya dayalı durum belirleme. Ankara: *Pegem Akademi*.

Lu, J. J., & Fletcher, G. H. (2009). Thinking about computational thinking. *ACM SIGCSE Bulletin*, 41(1), 260-264.

MEB TTK. (2018). Ortaöğretim Kurumları Haftalık Ders Çizelgesi. Ankara: *Talim ve Terbiye Kurulu Başkanlığı*.

MEB. (2018). Matematik Öğretim Programı. http://mufredat.meb.gov.tr/Programlar.aspx. Erişim Tarihi: 9/01/2023.

Nunnally, B. H. & Bernstein, J.C. (1994). Psychometric theory (3rd ed.). London, UK: McGraw-Hill

Papert, S. (1980). Teaching children to be mathematicians us. *teaching about mathematics (No. 249). memo.*

Polya, G. (1945). *How to solve it; a new aspect of mathematical method*. Princeton University Press.

Raykov T. (1998). Coefficient alpha and composite reliability with ınterrelated nonhomogeneous ıtems. *Applied Psychological Measurement, 22(4), 375-385.*

Román-González, M., Pérez-González, J. C., & Jiménez-Fernández, C. (2017). Which cognitive abilities underlie computational thinking? Criterion validity of the Computational Thinking Test. *Computers in human behavior*, *72*, 678-691.

Selby, C., & Woollard, J. (2013). Computational thinking: The developing definition. https://eprints.soton.ac.uk/356481/

Sherin, B., diSessa, A. A., & Hammer, D. (1993). Dynaturtle revisited: Learning physics through collaborative design of a computer model. *Interactive Learning Environments*, 3(2), 91-118.

Sneider, C., Stephenson, C., Schafer, B., & Flick, L. (2014). Exploring the science framework and NGSS: Computational thinking in the science classroom. *Science Scope*, 38(3), 10-15.

Şencan, H. (2005). Sosyal ve davranışsal ölçümlerde güvenilirlik ve geçerlilik. Ankara: *Seçkin Yayınevi*

Tang, X., Yin, Y., Lin, Q., Hadad, R., & Zhai, X. (2020). Assessing computational thinking: A systematic review of empirical studies. *Computers & Education*, 148, 103798. https://doi.org/10.1016/j.compedu.2019.103798

Tsai, M.-J. (1999). The impact of strategic and cooperative learning on Taiwanese eighth graders' computer achievement, attitudes, and anxiety (Unpublished Doctoral Dissertation). *The University of Texas at Austin*, Austin, TX, USA.

Tsai, M.-J., Wang, C.-Y., & Hsu, P.-F. (2019). Developing the Computer Programming Self-Efficacy Scale (CPSES) for computer literacy education. *Journal of Educational Computing Research*, 56(8), 1345–1360. https://doi.org/10.1177/0735633117746747

Tsai, M. J., Liang, J. C., & Hsu, C. Y. (2021). The computational thinking scale for computer literacy education*. Journal of Educational Computing Research*, 59(4), 579-602.

Tsai, M. J., Liang, J. C., Lee, S. W. Y., & Hsu, C. Y. (2022). Structural validation for the developmental model of computational thinking. *Journal of Educational Computing Research*, 60(1), 56-73.

Weintrop, D., Beheshti, E., Horn, M., Orton, K., Jona, K., Trouille, L., & Wilensky, U. (2016). Defining computational thinking for mathematics and science classrooms. *Journal of Science Education and Technology*, 25(1), 127–147. https://doi.org/10. 1007/s10956-015-9581-5

Wing, J. M. (2006). Computational thinking. Communications of the ACM, 49, 33–36.

Wing, J. M. (2008). Computational thinking and thinking about computing. Philosophical Transactions of the Royal Society A – *Mathematical Physical and Engineering Sciences*, 366(1881), 3717–3725.

Wing, J. M. (2011). Research notebook: Computational thinking – what and why? *The link*. Carneige Mellon.

Yadav, A., Mayfield, C., Zhou, N., Hambrusch, S., & Korb, J. T. (2014). Computational thinking in elementary and secondary teacher education. *ACM Transactions on Computing Education* (TOCE), 14(1), 1–16. https://doi.org/10.1145/2576872

Yağcı, M. (2019). Bilişimsel düşünme becerilerini incelemek için geçerli ve güvenilir bir araç. *Eğitim ve Bilgi Teknolojileri*, *24* (1), 929-951

Appendix 1
Computational Thinking Scale (Turkish Form)

Aşağıdaki her bir ifade için görüşünüzü yandaki uygun kutucuğu işaretleyerek belirtiniz:
(1) Hiç Katılmıyorum, (2) Katılmıyorum, (3) Kısmen Katılıyorum, (4) Katılıyorum, (5) Tamamen Katılıyorum

1. Detaylarla uğraşmak yerine genellikle problemi bir bütün bakış açısıyla düşünürüm.	1	2	3	4	5
2. Genellikle farklı problemler arasındaki ilişkiler hakkında düşünürüm.	1	2	3	4	5
3. Genellikle bir problemin temel noktalarını bulmaya çalışırım.	1	2	3	4	5
4. Genellikle farklı problemlerin ortak modellerini analiz etmeye çalışırım.	1	2	3	4	5
5. Genellikle bir problemi parçalara ayırmanın mümkün olup olmayacağını düşünürüm.	1	2	3	4	5
6. Genellikle bir problemin yapısını düşünürüm.	1	2	3	4	5
7. Genellikle büyük bir problemi küçük birkaç probleme nasıl böleceğimi düşünürüm.	1	2	3	4	5
8. Bir çözüm için işlem yollarını adım adım uygulamaya alışığımdır.	1	2	3	4	5
9. Genellikle bir problem için etkili çözümler bulmaya çalışırım.	1	2	3	4	5
10. Genellikle bir çözümün adımlarını düzenlemeye çalışırım.	1	2	3	4	5
11. Genellikle bir probleme bir çözümün nasıl uygulanacağını bulmaya çalışırım.	1	2	3	4	5
12. Bir problem için doğru bir çözüm bulmaya yönelirim.	1	2	3	4	5
13. Genellikle bir program için en iyi çözümü düşünürüm.	1	2	3	4	5
14. Genellikle bir problem için en etkili çözümü bulmaya çalışırım.	1	2	3	4	5
15. Genellikle bir problem için en hızlı çözümü düşünürüm.	1	2	3	4	5
16. Yeni bir problemi kendi deneyimime göre çözmeye yönelirim.	1	2	3	4	5
17. Genellikle farklı problemleri çözmek için yaygın bir yol kullanmaya çalışırım.	1	2	3	4	5
18. Genellikle bir çözümü diğer problemlere nasıl uygulayacağımı düşünürüm	1	2	3	4	5
19. Genellikle daha fazla problem çözmek için bilindik bir çözüm uygulamaya çalışırım.	1	2	3	4	5