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Computational Thinking Skills of Turkish and Indian Teacher Candidates: A Comparative Study

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ABSTRACT

The aim of this study is to compare computational thinking skills of teacher candidates who are educated in Turkey and India. For this purpose, 555 male and 212 female who are students in the Faculty of Education at a University in Turkey and, 239 male and 493 female who are students in Faculty of Education at University of Madras in India. Within the scope of the research, the "computer thinking skill levels scale" developed by Korkmaz, Çakır and Özden (2017) to measure the computer thinking skills of university students in Turkey was used. The scale consists of 29 items and five factors. The Cronbach alpha of Scale' Turkish form is .822 and, Indian form is .769. Mean, standard deviation, t-test and ANOVA analyses were run on the collected data. According to the results, computational thinking skills of Indian teacher candidates are generally quite high, whereas Turkish teacher candidates are moderately high, and in both groups the students' highest level in term of factors is creativity, and the lowest one is problem-solving skill.

Keywords:[1]
Computational thinking; teacher training; cultural and social implications

1. Introduction

Technological advancements have swept up the interests of individuals in the society. All spheres of a human life are now centered with a computer or an application of computer science. People now ask questions related to three drivers - science, technology and society (Wing, 2006). Millennial generation children are exposed to computers in their early ages. Moreover, these children are not afraid to play and explore new things with technology. To capture this skill formally researchers and educators needed a tool. Bundy (2007) claims that a person who tries to understand the fast moving 21st century is obliged to understand the computational thinking (CT) first.

Jeanette Wing (2006) in a seminal paper described CT as a way of "solving problems, designing systems, and understanding human behavior by drawing on the concepts fundamental to computer science." CT has an analytical approach to understand computability, intelligence, the mind and human behaviour. It also includes concepts such as analysis, demonstration and modelling (Kormaz, Çakir & Özden, 2017). Individuals' opportunity to access and share information has led them to resolving the problems of the hectic world. This trait of resolving problems is a subject of computational thinking skills (Wing, Henderson, Hazzan, & Cortina, 2005; Wing, 2006; Guzdial, 2008). There are limited number of studies that measures digital age skills. It is a concealed fact, to measure how much of digital age skills like computational thinking skills is present in the millennial generation. Educators and researchers these days finds it necessary to study the concepts of computational thinking in schools. They focus on teaching learning process in schools with computer

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programming exercises. Educational researchers sometimes referred twenty first century skills as computational thinking. Such activities to teach CT skills comprises of activities like strings or physical movements and logic cards that help the student learn computer science concepts. However, there is lack of studies from the pedagogical practices or pre-service teachers' instructional method that will help in students' computational thinking. CT research in Indian context is also native. There is lack of empirical evidence on the measurement of the umbrella factors of computational thinking in India.

1.1. Review of Literature

The first concepts of computational thinking detailed that students could improve procedural thinking through programming. Later, after many years the concept of computational thinking was developed into a field of study by Wing (2006). Her research argued that computational thinking is a fundamental skill that students learn and recommended that the training for students should be implemented in the early school years. This skill will help students to streamline things into a process and solve complex problems. Currently, there is no one unanimous definition of computational thinking. However, researchers have accepted that computational thinking is a thought process that includes various elements of critical thinking, generalization, abstraction, algorithmic thinking and detection and correction of errors. Another study defines computational thinking skill as a problem-solving skill that helps to initially understand what the problem is and then thinking of the solutions (Curzon, 2015). In a recent study of use of technology tools, researchers have found that students of 21st century prefer mobile devices than the traditional tools.

Recently, The International Society for Technology in Education (ISTE, 2015) defined computational thinking as a common reflection of creativity, algorithmic thinking, critical thinking, problem solving, cooperative thinking and communication skills. Thus, from earlier researches we can see that the factors mentioned in ISTE definition are the skills are the ones that are discussed most in the case of computational thinking skills. Korkmaz and others (2017) have also checked the validity and reliability of these factors in a study of computational thinking skills. The factors are mentioned as below:

a) *Creative thinking* – Creative thinking is one of the prominent skills of the new age that helps in gaining new insights in many areas such as technology, manufacturing, art, science and many more. Creativity is also considered as a competency-based skill to encounter the complex world (Wang, Schneider & Valacich, 2015). Maor (2017) in his research has mentioned that creative thinking is essential for the teachers to develop their abilities technology in an innovative method.

b) *Algorithmic thinking* – Brown (2015) defined algorithmic thinking as a skill of understanding, applying and assessing producing algorithms. To be an algorithmic thinker understanding and assessing the situation is crucial. An algorithmic thinker will be meticulous and determined in completing the tasks. Studies suggests that algorithmic thinking is the most appropriate way to solve the problem systematically and hence also called as systematic thinking (Yadav, Mayfield, Zhou, Hambrusch & Korb, 2014; Yadav, Stepheson & Hong, 2017).

c) *Critical thinking* – With the prevailing traditional style of education system we observe that it is rote learning is insufficient meet the human power of the information age (Kormaz et al., 2017). Literature supports that critical thinking is a must for the educators in order to achieve a desired skill (Qing, Jing & Yan, 2010). On experimenting computational thinking on preservice teachers, critical thinking was incorporated with computational thinking. A study conducted by Bower and Falkner (2015) concluded that preservice teachers associate computational thinking with critical thinking. Hence, critical thinking can be considered as a crucial component of computational thinking.

d) *Problem solving* – Technology advancements and computer science have brought enormous insights on solving human inquiries. The digital generation students learn how to think and solve problems bringing in computational processes (Barr & Stephenson, 2011). Wing (2011) redefined computational thinking as the "thoughtful processes involved in formulating problems and their solutions so that the solutions are represented in a form that can be effectively carried out by an information-processing agent".

e) *Cooperativity* – Researchers have defined as a group or cooperative learning where the students help each other to learn an academic subject (Johnson, Johnson and Smith, 2007). For the students of the information age peer learning is a method for academic success and establishing social relations. A study conducted

on students using coding shows that cooperativity was an active means in problem solving and interaction among students (Standl, 2016).

f) *Communication Skills* – According to ISTE (2015), computational thinking in an individual is used for algorithmic thinking and problem solving only when the individual cooperates with the environment. Computational thinking is expected to happen when there is a healthy communication and cooperativity is high. Communication skills are important in teaching profession. It checks the educators' power to perform their job. Teachers will be able to share their resources and transfer their knowledge with good communication skills.

1.2. Computational thinking and teacher education

In recent years, the curriculum in schools are undertaking a redesign by embracing computational thinking considering it essential for students. Advancement in computer and mobile technology has changed the learning interests of students. Bundy (2007) posited that computational thinking is important for understanding concepts in every field by the method of algorithmic thinking and problem solving. There are studies that proves the positive relationship of computational thinking and students' academic performance (Doleck, Bazelais, Lemay, Saxena and Basnet, 2017). The supprt systems in educational instituitions should also be aware of the consequences of computational thinking training for students. Teachers are expected to incorporate computational thinking into the teaching and learning practices (Yadav et al., 2014). Teachers and preservice teachers can be provided with oppurtunities online to reinforce their abiities in computational thinking (Yadav, Hong & Stephenson, 2016). Studies shows that students from different background using their analytical and problem-solving skills to solve task in their introductory computer science papers (Lewandowski, Bouvier, McCartney, Sanders & Simon, 2007). Similarly, a study conducted by Hambrusch and colleagues (2009) found that teaching computational thinking in undergraduate science programme significantly improves students' attitude and interest. Understanding the impact of computational thinking in the academic performance of the students of various ages, it is important for the pre-service teachers to inculcate the skill in themselves and further implement them in the classroom teaching. This study will help to understand the computational thinking skills that both Turkish and Indian teacher candidates have.

Problem question in research "What are the computational thinking skills levels of Turkish and Indian teacher candidates?" determined as. In addition, answers were sought for the sub-problems given below.

a) What are the computational thinking skills levels of Turkish and Indian teacher candidates in general?

b) Is there a significant difference between Turkish and Indian teacher candidates' computational thinking skills?

c) Is there a gender difference between the level of computational thinking skills of Turkish and Indian teacher candidates?

d) Is there a significant difference between the level of computational thinking skills of Turkish and Indian teacher candidates according to departments?

e) Is there a significant difference between computational thinking skill levels of Turkish and Indian teacher candidates according to grade levels?

2. Method

2.1. Research Design

This study was carried out in the descriptive survey method. In this study, computational thinking skill levels of teacher candidates who are studying in Turkey and India have been tried to be described comparatively.

2.2. Participants

The participants of the study consist of 555 male and 212 female who are students in the Faculty of Education at a University in Turkey. 239 male and 493 female who are students in Faculty of Education at University of Madras, India. The distribution of teacher candidates by Country, Department and class levels is summarized in Table1.

Table 1. Distribution of the working group by country, department and class

			First grade	Second grade	Third grade	Fourth grade	Total
Science Ed.	Country	India	42	41	53	28	164
		Turkey	25	36	37	40	138
	Total		67	77	90	68	302
Math. Ed.	Country	India	41	70	53	34	198
		Turkey	47	47	61	41	196
	Total		88	117	114	75	394
Language Ed.	Country	India	33	56	56	39	184
		Turkey	79	82	72	51	284
	Total		112	138	128	90	468
Social Science Ed.	Country	India	35	56	57	38	186
		Turkey	34	37	36	42	149
	Total		69	93	93	80	335

2.3. Measuring Tool

In the scope of the study, the computational thinking skill scale was designed by Korkmaz, Çakır and Özden (2017) to measure the computational thinking skills of university students in Turkey. The scale consists of 29 items and five factors. The validity and reliability study of the scale was carried out separately in two different study groups, one consisting of faculty of education and faculty of engineering students and the other composed of students studying in the faculty of science and literature, faculty of theology and faculty of health sciences. The factors on the scale, the number of items and the internal consistency coefficients are summarized in Table 2.

Table 2. Reliability analysis results considering the whole of the scale and its factors for undergraduate students

Factors	Number of items	Cronbach's Alpha
Creativity	8	.843
Algorithmic Thinking	6	.869
Cooperativity	4	.865
Critical Thinking	5	.784
Problem Solving	6	.727
Total	29	.822

For Indian teacher candidates, the English form of the same scale was used. Exploratory factor analysis was carried out to investigate whether the English form of the scale is valid and reliable in Indian culture. In order to test the structure validity of Computational Thinking Scale, Kaiser-Meyer-Oklin (KMO) and Bartlett tests were first performed and KMO= 0.851; Bartlett Test value was $\chi 2$= 12605.310 SD=406 (p=0.000). Within the framework of these values, it is understood that factor analysis can be done on 29 item scale. It has been determined that the factor loads of 29 items are between 0.250 and 0.694 without being subjected to rotation (unrotated). The reliability level of the scale was tested through the Cronbach Alpha internal consistency coefficient. The factors on the scale, the number of items and the internal consistency coefficients are summarized in Table 3.

Table 3. Reliability analysis results for Indian teacher candidates

Factors	Number of items	Cronbach's Alpha
Creativity	8	.642
Algorithmic Thinking	6	.853
Cooperativity	4	.813
Critical Thinking	5	.678
Problem Solving	6	.803
Total	29	.769

Table 3 shows the internal consistency coefficient for the whole scale is 0.769. In terms of factors, internal consistency coefficients vary between 0.642 and 0.853, and internal consistency coefficients for Creativity and Critical Thinking factors are less than 0.70.

3. Results

The descriptive results of the computational thinking skills of Turkish and Indian teacher candidates are summarized in Table 4.

Table 4. Students' computational thinking skill levels

	Factors	N	$\bar{X}$	SD	Low		Medium		High	
Indian	Creativity (C)	732	77.0	9.9	7	1.0	101	13.8	624	85.2
	Algorithmic Thinking (A)		69.8	13.3	75	10.2	217	29.6	440	60.1
	Cooperativity (O)		78.5	13.3	22	3.0	124	16.9	586	80.1
	Critical Thinking (T)		75.7	11.4	13	1.8	129	17.6	590	80.6
	Problem Solving (P)		66.5	14.5	111	15.2	234	32.0	387	52.9
	Computational Thinking Levels		73.3	6.4	1	0.1	112	15.3	619	84.6
Turkish	Creativity (C)	767	83.1	10.4	10	1.3	33	4.3	724	94.4
	Algorithmic Thinking (A)		59.6	20.7	285	37.2	189	24.6	293	38.2
	Cooperativity (O)		73.4	19.5	105	13.7	163	21.3	499	65.1
	Critical Thinking (T)		70.6	14.7	65	8.5	230	26.5	499	65.1
	Problem Solving (P)		47.6	15.7	488	63.6	204	26.6	75	9.8
	Computational Thinking Levels		67.4	8.5	21	2.7	357	46.5	389	50.7

As shown in Table 3, computational thinking skills scores of Indian teacher candidates range from 49 to 91; average is $\bar{X}$=73.3. It is observed that 84.6% of these teacher candidates have high skill levels, 15.3% have moderate level and only 0.1% have low level. When we look at the factors, it is observed that the factor with the highest mean is cooperativity ($\bar{X}$ =78.5) and the factors with the lowest mean is problem solving ($\bar{X}$ =66.5). On the other hand, it is observed that the highest level of skill in the group is creativity (85.2%) and the lowest level is problem solving (52.9%). According to this, it was found that the students' computational thinking skills were quite high in general and the highest factor is creativity and the lowest one is problem solving.

As for Turkish teacher candidates, it is observed that the computer thinking skills scores range from 37 to 94 and the mean is $\bar{X}$=67.4. It is observed that 50.7% of these teacher candidates have a high level of skills and 46.5% have a moderate level and 2.7% have a low level. It was observed that the highest mean of the factors was Creativity ($\bar{X}$ =83.1) and the lowest mean of the factors was Problem Solving ($\bar{X}$ =47.6). It was observed that the highest level of skills in the group was Creativity (94.4%) and the lowest level in the group was Problem Solving" (9.8%). According to this, it can be said that the Turkish teacher candidates' computational thinking skills are generally moderate, and the students' highest-level skills are Creativity and the lowest ones are Problem Solving. In comparison, it is observed that the computer-based thinking skills levels of Indian teacher candidates are higher than Turkish teacher candidates in terms of total scores. In terms of factors, it is observed that the skill levels of Indian teacher candidates are higher than those of Turkish teacher candidates in terms of all other factors except the creativity factor. In terms of creativity, it is observed that the higher the skill levels of teacher candidates. It can be said that the level of computational thinking skills is higher than the level of Turkish teacher candidates except for the Creativity factor of Indian teacher candidates.

Table 5. Differences between Indian and Turkish teacher candidates' computational thinking skills

Factors		N	$\bar{X}$	Sd	t	df	P
Creativity (C)	Indian	732	77.0	9.9	-11.511	1497	.000
	Turkish	767	83.1	10.4			
Algorithmic Thinking (A)	Indian	732	69.8	13.3	11.295		.000
	Turkish	767	59.6	20.7			
Cooperativity (O)	Indian	732	78.5	13.3	5.846		.000
	Turkish	767	73.4	19.5			
Critical Thinking (T)	Indian	732	75.7	11.4	7.578		.000
	Turkish	767	70.6	14.7			
Problem Solving (P)	Indian	732	66.5	14.5	24.128		.000
	Turkish	767	47.6	15.7			
Computational Thinking Levels	Indian	732	73.3	6.42	15.161		.000
	Turkish	767	67,4	8,5			

As shown in Table 5, there is a significant difference in terms of both factors (Creativity: $t_{(2-1497)}$=-11.511.161; p<0.001, Algorithmic Thinking: $t_{(2-1497)}$=11,295; p<0.001, Cooperativity: $t_{(2-1497)}$=5,846; p<0.001, Critical Thinking: $t_{(2-1497)}$=7.578; p<0.001, Problem Solving: $t_{(2-1497)}$=24.128; p<0.001 and total score ($t_{(2-1497)}$ = 15.161; p<0.001). When the mean scores are examined, it is observed that differentiation in factor of creativity is in favor of Turkish teacher candidates. In terms of other factors and total scores, it is seen that the Indian teacher candidates are in favor. It can be said that computational thinking skill levels of Indian teacher candidates are significantly higher than Turkish teacher candidates in terms of all the factors and total score except creativity. On the other hand, it can be said that Turkish teacher candidates' skill levels are significantly higher in terms of creativity.

The results of the differences between computational thinking skill levels of teacher candidates according to gender are summarized in Table 6.

Table 6. Differences between computational thinking skill levels of teacher candidates according to gender

	Factors		N	$\bar{X}$	Sd	t	df	p
Indian	Creativity (C)	Male	239	77.2	9.7	.298	730	.767
		Female	493	76.9	10.1			
	Algorithmic Thinking (A)	Male	239	68.5	13.8	-1.788		.074
		Female	493	70.4	13.1			
	Cooperativity (O)	Male	239	77.9	12.9	-.727		.468
		Female	493	78.7	13.5			
	Critical Thinking (T)	Male	239	76.2	10.6	.698		.485
		Female	493	75.5	11.8			
	Problem Solving (P)	Male	239	67.9	13.9	1.973		.049
		Female	493	65.7	14.8			
	Computational Thinking Levels	Male	239	73.4	6.1	.289		.772
		Female	493	73.3	6.6			
Turkish	Creativity (C)	Male	555	83.3	10.6	.906	765	.365
		Female	212	82.5	9.9			
	Algorithmic Thinking (A)	Male	555	60.2	20.8	1.313		.189
		Female	212	58.0	20.4			
	Cooperativity (O)	Male	555	73.4	19.9	-.122		.903
		Female	212	73.6	18.3			
	Critical Thinking (T)	Male	555	70.2	15.1	-1.036		.301
		Female	212	71.5	13.8			
	Problem Solving (P)	Male	555	46.2	14.7	-4.129		.000
		Female	212	51.4	17.4			
	Computational Thinking Levels	Male	555	67.2	8.3	-.919		.358
		Female	212	67.9	8.9			

Table 6 shows that there is no significant difference between Indian male and female teacher candidates in terms of both total scores and all factors. When Turkish teacher candidates are examined, it is seen that there is no significant difference between female and male pre-service teachers in terms of all factors and total score except for problem solving. However, there is a significant difference between Turkish female teacher candidates and male teacher candidates in favor of female teacher candidates in problem solving factor ($t_{(2-1497)}$=-2,4129); p<0.001). According to this result, it is possible to say that the problem-solving skills of Turkish female teacher candidates are significantly higher than Turkish male teacher candidates, and that both Indian and Turkish teacher candidates are similar to computational thinking skills. In terms of gender, the findings regarding the differentiation between the computational thinking skills levels of Turkish and Indian teacher candidates are summarized in Table 7.

Table 7. Gender Differences between Indian and Turkish teacher candidates' Computational Thinking Skills

	Factors		N	$\bar{X}$	Sd	t	df	p
Males	Creativity (C)	India	239	77.2	9.7	-7.649	792	.000
		Turkey	555	83.3	10.6			
	Algorithmic Thinking (A)	India	239	68.5	13.8	5.68		.000
		Turkey	555	60.2	20.8			
	Cooperativity (O)	India	239	77.9	12.9	3.281		.001

		Turkey	555	73.4	19.9			
	Critical Thinking (T)	India	239	76.2	10.6	5.535		.000
		Turkey	555	70.2	15.1			
	Problem Solving (P)	India	239	67.9	13.9	19.449		.000
		Turkey	555	46.2	14.7			
	Computational Thinking Levels	India	239	73.4	6.1	10.385		.000
		Turkey	555	67.2	8.3			
Females	Creativity (C)	India	493	76.9	10.1	-6.777	703	.000
		Turkey	212	82.5	9.9			
	Algorithmic Thinking (A)	India	493	70.4	13.0	9.676		.000
		Turkey	212	58.0	20.4			
	Cooperativity (O)	India	493	78.7	13.5	1.174		.000
		Turkey	212	73.6	18.3			
	Critical Thinking (T)	India	493	75.5	11.8	3.991		.000
		Turkey	212	71.5	13.8			
	Problem Solving (P)	India	493	65.7	14.8	11.214		.000
		Turkey	212	51.4	17.4			
	Computational Thinking Levels	India	493	73.3	6.6	8.926		.000
		Turkey	212	67.9	8.9			

Table 7 shows that female Turkish teacher candidates have significantly higher Creativity skills than male teachers candidates (male: $(t_{(2-792)} = -7.649; p < 0.001$, Female: $(t_{(2-703)} = -6.777; p < 0.001)$ On the other hand, when the other factors and total scores are examined, it is seen that computational thinking skills of Indian teacher candidates are significantly higher than Turkish teacher candidates. While the Creativity skill of the pre-service teachers is significantly higher, it can be said that the Indian female and male teacher candidates are significantly higher than the other skill levels and total scores of computational thinking skills. Table 8 summarizes the findings related to the level of computational thinking of Turkish and Indian teacher candidates according to the departments.

Table 8. Indian and Turkish teachers' computational thinking levels according to departments

		India			**Turkey**		
Factors	**Departments**	**N**	**$\bar{X}$**	**Sd**	**N**	**$\bar{X}$**	**Sd**
Creativity (C)	Science	164	77.9	9.9	138	84.4	9.5
	Math	198	75.8	9.7	196	82.4	9.6
	Language	184	77.4	10.1	284	82.6	11.7
	Social Science	186	77.1	10.2	149	83.6	9.8
Algorithmic Thinking (A)	Science	164	67.9	13.7	138	70.4	14.8
	Math	198	72.6	10.9	196	75.5	12.8
	Language	184	70.9	13.5	284	48.1	18.8
	Social Science	186	67.3	14.3	149	50.7	18.5
Cooperativity (O)	Science	164	80.5	13.2	138	76.1	18.8
	Math	198	76.4	13.7	196	71.8	18.6
	Language	184	78.5	13.8	284	73.1	20.5
	Social Science	186	78.8	12.1	149	73.9	19.2
Critical Thinking (T)	Science	164	76.8	11.7	138	74.7	11.9
	Math	198	75.5	12.2	196	71.5	13.3
	Language	184	75.3	10.9	284	68.4	16.4
	Social Science	186	75.5	10.9	149	69.7	14.7
Problem Solving (P)	Science	164	63.4	15.5	138	46.5	15.9
	Math	198	69.6	13.9	196	43.1	13.5
	Language	184	67.1	13.5	284	50.7	16.5
	Social Science	186	65.3	14.6	149	48.7	15.3
Computational Thinking Levels	Science	164	72.9	6.7	138	70.8	7.2
	Math	198	73.9	6.1	196	69.5	7.1
	Language	184	73.7	6.2	284	65.1	9.4
	Social Science	186	72.5	6.7	149	65.8	7.8

In Table 8, the mean score of Turkish and Indian teacher candidates of computational thinking skills are examined separately, the level of skills of Turkish and Indian teacher candidates are very close to each other

for all departments in terms of creativity. It is observed that the skill levels of Indian and Turkish teacher candidates differ in all departments in term of algorithmic thinking. In Cooperative Learning, it is observed that the skill levels of Indian and Turkish teacher candidates differ in all departments, and in both groups the skill levels of science teacher candidates are higher than the other departments. Critical thinking skill levels of teacher candidates in terms of Indian close to each other and differed in terms of the skill level of Turkish teacher candidates. In both groups, it is observed that science education teacher candidates' skill levels are higher than others. It is observed that the skill levels of Indian and Turkish teacher candidates differ from all departments in terms of Problem Solving. In terms of computational thinking total scores, it is observed that the level of skills of Indian teacher candidates is close to each other But Turkish teacher candidates in language education and social studies education departments are lower than other departments.

On the other hand, comparing Turkish and Indian teacher candidates, in all departments, the level of creativity skills of Turkish teacher candidates is higher. It is observed that Turkish teacher candidates in science education and mathematics education departments have higher Algorithmic Thinking skill levels compared to Indian students. According to the language education and social studies education departments, the Algorithmic Thinking skill levels of Turkish teacher candidates are very low compared to Indian teacher candidates. In all departments, the Cooperative Learning, Critical Thinking and Problem-Solving skills levels of Turkish teacher candidates are lower. However, the Problem-Solving skill levels of teacher candidates in both groups are quite low compared to other skill levels. In general, in all departments, it is observed that Turkish teacher candidates have lower computational thinking skills compared to the Indian teacher candidates. The results of ANOVA test related to whether these differentiations is meaningful are summarized in Table 9.

Table 9. The effects of departments on Indian and Turkish teachers' candidates' computational thinking skill levels

	Factors		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**	**LSD**
India	Creativity (C)	Bet.G.	427.536	3	142.512	1.441	.230	---
		Wit. G.	71994.211	728	98.893			
		Tot.	72421.747	731				
	Algorithmic Thinking (A)	Bet.G.	3545.176	3	1181.725	6.851	.000	Between Social Science, Science and Math, language
		Wit. G.	125568.531	728	172.484			
		Tot.	129113.707	731				
	Cooperativity (O)	Bet.G.	1551.535	3	517.178	2.950	.032	Between Science and Math
		Wit. G.	127615.268	728	175.296			
		Tot.	129166.803	731				
	Critical Thinking (T)	Bet.G.	221.088	3	73.696	.562	.640	---
		Wit. G.	95458.628	728	131.124			
		Tot.	95679.716	731				
	Problem Solving (P)	Bet.G.	3749.745	3	1249.915	6.065	.000	Between Science and Math, Language
		Wit. G.	150030.628	728	206.086			
		Tot.	153780.373	731				
	Computational Thinking Levels	Bet.G.	212.255	3	70.752	1.719	. 162	---
		Wit. G.	29957.649	728	41.151			
		Tot.	30169.904	731				
Turkey	Creativity (C)	Bet.G.	440.629	3	146.876	1.353	.256	---
		Wit. G.	82846.740	763	108.580			
		Tot.	83287.370	766				
	Algorithmic Thinking (A)	Bet.G.	114822.039	3	38274.013	136.67	.000	Between Science, Math and Social science, Language
		Wit. G.	213672.181	763	280.042			
		Tot.	328494.220	766				
	Cooperativity (O)	Bet.G.	1629.249	3	543.083	1.432	.232	---
		Wit. G.	289461.886	763	379.373			
		Tot.	291091.134	766				
	Critical Thinking (T)	Bet.G.	3983.570	3	1327.857	6.231	.000	Between Science, Social Science and Language
		Wit. G.	162587.360	763	213.090			
		Tot.	166570.931	766				

Problem Solving (P)	Bet.G.	7187.755	3	2395.918	10.074	.000	Between all departments
	Wit. G.	181469.698	763	237.837			
	Tot.	188657.453	766				
Computational Thinking Levels	Bet.G.	4306.912	3	1435.637	21.476	.000	Between Science, Math and Social science, Language
	Wit. G.	51005.789	763	66.849			
	Tot.	55312.701	766				

Table 9 shows that there is a significant difference on Algorithmic Thinking ($F_{(3-728)}$=6,851; p<0.01), Cooperativity ($F_{(3-728)}$=2,950; p<0.01) and Problem Solving ($F_{(3-728)}$=6,065; p<0.01) skills between departments of Indian teacher candidates. According to the results of LSD test, teacher candidates of mathematics and language education have significantly higher Algorithmic Thinking skill levels compared to teacher candidates in social sciences and science education departments. It is observed that Cooperative skill levels of teacher candidates in science education are significantly higher than those of teacher candidates in mathematics education. Problem Solving skill levels of teacher candidates who have been educated in mathematics and language education are significantly higher than those of teacher candidates in Science Education departments.

Table 9 shows that there is a significant difference on the Algorithmic Thinking ($f_{(3-763)}$=136,672; p<0.01), Critical Thinking($f_{(3-763)}$=6,231; p<0.01), Problem Solving ($f_{(3-763)}$=10,074; p<0.01) and total score ($F_{(3-763)}$=21,476; p<0.01) skills between departments of Turkish teacher candidates. The results of the LSD test show that the level of Algorithmic Thinking skill levels of teacher candidates in science and mathematics departments are significantly higher than teacher candidates in social studies and language education departments. Critical thinking skill levels of teacher candidates in science education department are significantly higher than teacher candidates in social studies and language education departments. Teacher candidates in science and language education departments have higher Problem-Solving skill levels than those in mathematics and social studies education departments, while teacher candidates in Language Education Department have the highest level. It is observed that the level of skills of teachers in science and mathematics education in terms of total score of computational thinking is significantly higher than teacher candidates in language and social studies education. Table 10 summarizes the findings related to the level of computational thinking of Turkish and Indian teacher candidates according to the grade levels.

Table 10. Indian and Turkish teachers' computational thinking levels according to grade levels

		India			Turkey		
Factors	**Grade**	**N**	**$\bar{X}$**	**Sd**	**N**	**$\bar{X}$**	**Sd**
Creativity (C)	1.	151	77.57	10.5	185	81.5	11.1
	2.	223	77.21	9.9	202	82.7	9.8
	3.	219	77.53	9.5	206	83.4	10.6
	4.	139	75.20	10.1	174	84.7	10.1
Algorithmic Thinking (A)	1.	151	68.12	12.9	185	56.9	20.8
	2.	223	70.46	12.6	202	60.8	20.3
	3.	219	70.33	13.2	206	58.5	19.6
	4.	139	69.69	14.7	174	62.2	22.1
Cooperativity (O)	1.	151	77.42	13.2	185	74.8	20.7
	2.	223	79.06	13.7	202	72.9	19.8
	3.	219	79.06	13.4	206	73.9	18.3
	4.	139	77.81	12.5	174	71.8	19.3
Critical Thinking (T)	1.	151	74.38	11.9	185	69.1	15.1
	2.	223	75.91	12.1	202	69.9	15.3
	3.	219	76.47	11.1	206	71.3	13.9
	4.	139	75.80	10.2	174	71.9	14.7
Problem Solving (P)	1.	151	65.83	14.6	185	48.4	16.9
	2.	223	66.55	14.5	202	47.2	15.9
	3.	219	66.30	13.9	206	47.1	15.4
	4.	139	67.27	15.6	174	47.8	14.5
Computational Thinking Levels	1.	151	72.61	6.9	185	66.6	9.4
	2.	223	73.64	5.9	202	67.3	7.8
	3.	219	73.75	6.3	206	67.4	8.5
	4.	139	72.88	6.6	174	68.5	8.2

In Table 10, computational thinking skills of both Indian and Turkish teacher candidates are examined according to class levels, although there are small differences in both total scores and factors, it is observed that they are similar in general. In comparison, it is observed that Turkish teacher candidates at all class levels are higher than Indian teacher candidates at all class levels in terms of Creativity factor. However, in terms of other factors and total scores, it is observed that the level of skills of Indian teacher candidates at all grade levels is quite high among Turkish teacher candidates. The results of the analysis of variance about whether this differentiation is significant are summarized in Table 11.

Table 11. The effects of grade levels on Indian and Turkish teachers' candidates' computational thinking skills

	Factors		Sum of Squares	df	Mean Square	F	Sig.	LSD
India	Creativity (C)	Bet.G.	572.053	3	190.684	1.932	.123	---
		Wit. G.	71849.694	728	98.695			
		Tot.	72421.747	731				
	Algorithmic Thinking (A)	Bet.G.	586.851	3	195.617	1.108	.345	---
		Wit. G.	128526.856	728	176.548			
		Tot.	129113.707	731				
	Cooperativity (O)	Bet.G.	382.985	3	127.662	.722	.539	---
		Wit. G.	128783.818	728	176.901			
		Tot.	129166.803	731				
	Critical Thinking (T)	Bet.G.	402.816	3	134.272	1.026	.380	---
		Wit. G.	95276.900	728	130.875			
		Tot.	95679.716	731				
	Problem Solving (P)	Bet.G.	157.890	3	52.630	.249	.862	---
		Wit. G.	153622.484	728	211.020			
		Tot.	153780.373	731				
	Computational Thinking Levels	Bet.G.	164.908	3	54.969	1.334	.262	-
		Wit. G.	30004.996	728	41.216			
		Tot.	30169.904	731				
Turkey	Creativity (C)	Bet.G.	979.852	3	326.617	3.028	.029	Between 1st and 4th grade
		Wit. G.	82307.517	763	107.874			
		Tot.	83287.370	766				
	Algorithmic Thinking (A)	Bet.G.	3092.077	3	1030.692	2.417	.051	Between 1st and 4th grade
		Wit. G.	325402.143	763	426.477			
		Tot.	328494.220	766				
	Cooperativity (O)	Bet.G.	892.833	3	297.611	.782	.504	---
		Wit. G.	290198.301	763	380.339			
		Tot.	291091.134	766				
	Critical Thinking (T)	Bet.G.	890.093	3	296.698	1.366	.252	---
		Wit. G.	165680.838	763	217.144			
		Tot.	166570.931	766				
	Problem Solving (P)	Bet.G.	239.244	3	79.748	.323	.809	---
		Wit. G.	188418.210	763	246.944			
		Tot.	188657.453	766				
	Computational Thinking Levels	Bet.G.	329.759	3	109.920	1.525	.207	---
		Wit. G.	54982.942	763	72.062			
		Tot.	55312.701	766				

When Table 11 is examined, it is observed that there is no significant difference in terms of both the total scores of the Indian teacher candidates and the factors in terms of the class level. According to this, it can be said that the schools where they study have no meaningful contribution to computational thinking skills of Indian teacher candidates. When Turkish teacher candidates were examined, it was found that there was a significant difference on the skills of Creativity ($F_{(3-763)} = 3,028$; $p < 0,01$) and Algorithmic Thinking (F (3-763) = 2,417; $p < 0,01$) between grade levels. According to the LSD test results, it is observed that the skill levels of the 4th grade students are significantly higher than the first-grade students in terms of both factors.

4. Conclusion and Discussion

In general, computational thinking skills of Indian teacher candidates are quite high, while Turkish teacher candidates are moderate. In both groups, the students' highest level of skills in terms of factors is creativity and the lowest one is problem solving. In general, the lowest mean score of the students is the algorithmic thinking and problem-solving skills the highest skill is the cooperativity. In comparison, computational thinking skills levels of Indian teacher candidates are significantly higher than Turkish teacher candidates in terms of all factors except creativity. On the other hand, in terms of creativity, the skill levels of Turkish teacher candidates are significantly higher than their counterparts. This can be interpreted as the fact that Turkish students are more imaginative in terms of creativity, but at other skill levels Indian students are better than Turkish students.

This finding is consistent with the literature. For example, the results of the study by Yağcı (2018) indicated that high school students consider their computational thinking skills to be sufficient at a medium level. There is limited research in the field of computational thinking. However, it is possible to come across a lot of research on the basic skills that are directly related to computational thinking. By examining these skills, it can get an idea about students' computational thinking skills. Mathematical performances of eighth grade Turkish students in a TIMSS-R conducted by Dogan and Tatsuoka (2008) were evaluated and they stated that Turkish students comparatively with American students did not perform well when asked them to deal with uncertainty, derive rules and generalize from cases, to construct answers as opposed to selecting an answer from given alternatives, and to read and understand suggestions that require logical thinking. In another study conducted by Kanbay, Aslan, Işık and Kılıç (2013) on nursing students, it was determined that students' critical thinking tendency scores were at a moderate level and there was no difference between the students' critical thinking and problem-solving skills scores. Moreover, as the critical thinking points increased, problem solving skills increased and critical thinking and problem-solving skills were not different according to gender.

As discussed in the introduction, the authors could not find much study on the level of computational thinking in Indian students. Computational thinking studies conducted in India by Shyamala et al. (2017) and Soman, Kumar, Soumya, and Shajeesh (2012) suggest that the Indian students have preferably high computational thinking skills, but they need to be trained hands on to develop the skill. Authors could not find any specific study which measured the level of creativity, problem solving, algorithmic thinking, communication skills, cooperativity or critical thinking skill. This study will contribute toward theoretical aspects of computational thinking pertaining to Indian context.

Turkish female teacher candidates' problem-solving skills are significantly higher than Turkish male teacher candidates. Apart from that, both Indian and Turkish teacher candidates' computer thinking skills are similar in terms of gender. In comparison, Turkish female and male pre-service teachers have significantly higher Creativity skills, while Indian female and male pre-service teachers have significantly higher scores on other skill levels and computer thinking. When the related literature is examined; in a study by Atmatzidou and Demetriadis (2016), it was concluded that women's computer thinking skills were higher than males. In contrast, the study by Orton et al. (2016) found that men have high computer thinking skills. According to the research by Tümkaya, Aybek and Aldağ (2009), it was found that there is not a significant difference either in problem solving skills or in critical thinking disposition based on gender. This result is in line with previous research which found gender to be an insignificant variable in terms of university students' critical thinking dispositions (Kawashima & Shiomi, 2007)

Algorithmic Thinking skill levels of Indian teacher candidates in mathematics and language education departments are significantly higher than in social studies and science education departments. Cooperativity skill levels of Indian teacher candidates in science education departments are significantly higher than in mathematics education. Indian teacher candidates in mathematics and language education departments have significantly higher problem-solving skill levels than those in science education departments. There are no significant differences in terms of other factors and total score of computational thinking. Shyamala, Shunmuga Velayutham and Parameswaran (2017) in their research have given programming education to students by using Scratch and Raptor applications. After applications, the students' computational thinking and problem-solving skills were measured. According to result, the students observed that the education provided increases computational thinking, problem solving skills and motivation towards the lesson.

Similarly, Jaipal-Jamani and Angeli (2017) in the experimental study conducted by primary school teacher candidates on robotic self-efficacy and computational thinking skills, they found that students' self-efficacy and computational thinking skills were significantly influenced by the experimental process. These research results show that successful results can be achieved when students are given appropriate education to improve their thinking skills. It is possible to say that the main source of the difference between the departments is to include the contents of the students' thinking skills.

Algorithmic Thinking skill levels of Turkish teacher candidates in mathematics and science education departments are significantly higher than in social studies and language education departments. Critical Thinking skill levels of teacher candidates in science education departments are significantly higher than in social studies and language education departments. Problem Solving is a differentiation between all the sections in terms of skill levels. The teacher candidates in science and language education departments are significantly higher in the problem-solving skill levels, then mathematics and social studies education departments. The highest skill level of this factor is the teacher candidates in the language education department. In terms of the total score of computational thinking, the skill levels of teacher candidates in science and mathematics education are significantly higher than the teacher candidates in the department of language and social studies education. This situation can be interpreted that the students are related to the department they study. In the literature, there are studies in which the relationship between logical mathematical intelligence and mathematics academic achievement are stated (Barcelos & Silveira, 2012). It can be thought that programs applied in mathematics, science education departments significantly contribute to students' computer thinking skill levels significantly more than other departments. Indeed, in a study by Korkmaz et al. (2015) found similar results. In a study conducted by Yadav, Gretter, Good and McLean (2017) about computational thinking skills for prospective teachers who are not previously familiar with information technologies, he states that prospective teachers have superficial computational thinking skills. However, at the end of the education given, they determined that there are developments in Problem Solving skills, Logical Thinking and Computational thinking skills.

In comparison to Turkish and Indian teacher candidates, the Creativity levels of Turkish teacher candidates are higher in all departments. The algorithmic Thinking skill levels of Turkish teacher candidates in science education and mathematics education departments are higher than those of Indian students. On the other hand, according to the language education and social studies education departments, the Algorithmic Thinking skill levels of Turkish teacher candidates are very low compared to Indian teacher candidates. In all departments, the Cooperative Learning, Critical Thinking and problem-solving skills levels of Turkish teacher candidates are lower than those of Indian teacher candidates. In terms of total points, Turkish teacher candidates in all departments have lower computational thinking skills levels.

The skill levels of Indian teacher candidates are not different in terms of grade levels. Accordingly, it can be said that there is no meaningful contribution of the teacher's candidates in India to the computational thinking skill levels. The schools where Turkish teacher candidates are educated contribute positively to Creativity and Algorithmic Thinking skills and do not contribute positively to other skill levels and total points. Compared to the Creativity factor, Turkish teacher candidates' skills levels at all grade levels are higher than those of Indian teacher candidates. On the other hand, the skill levels of Indian pre-service teachers in all grade levels in terms of other factors and total scores were higher than those of Turkish teacher candidates.

As a result of the research, it is seen that teacher candidates studying in both countries have a certain level of computational thinking, critical thinking and problem-solving skills. In addition, differences were found between the two countries due to different effects. In order to develop such skills, different applications can be developed and included in educational settings. For example, Wang et al. (2013) developed a computer-based application to improve computational thinking in a study. They have grasped the effect of the practice on teacher candidates. They also determined that the system prepared as a result of the research was effective on the teacher candidates' skills. On the other hand, Çiftci, Çengel and Paf (2018) found a significant positive relationship between the students' thinking skills and reflective thinking skills in problem solving. In this context, it is possible to say that different applications made in order to develop students' thinking skills in the implementation of training programs in India and Turkey. These different applications show that, while

developing students' creativity skills in Turkey has developed other sub factor skills level in India. In this context, it can be suggested to integrate the implementations which are thought to contribute to the computational thinking skills of students in Turkish teacher training programs by examining teacher training programs applied in India.

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