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A Study on High School Students' Critical Thinking Skills*

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Abstract. The aim of this quantitative study which employed a survey design was to determine the level of high school students' critical thinking (CT) skills and to investigate if high school students' CT skills differ by gender, father and mother's educational background, age, and grade level. Critical Thinking Skill Test for High School Students was used to collect data in this study conducted with 603 high school students. As a result of the study, it was found that students had high CT skills in terms of each sub-tests. Also, it was found that students' CT skills significantly differed by gender and educational background of their father and mother. Females and students who have a father and mother with higher educational degrees had higher CT skills. However, age and grade level did not significantly affect students' each sub-test scores and total test scores. These results of the current study were confirmed by the huge body of previous literature.

Keywords: Critical thinking skills, gender, age, demographic variables, high school students.

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1. INTRODUCTION

Schools need to change in order for students to develop the higher-order thinking, flexible problem solving, cooperation and communication skills required for success in the workplace and in everyday life. In other words, success both in life and work necessitates some 21st century skills such as higher-order thinking skills, communication and cooperation skills, information and media literacy, etc. (Binkley et al., 2012). In addition, globalization, economic necessity, and lack of civic engagement all add to the pressures on students and demand to acquire the skills and information they need to succeed and excel (Levy & Murnane, 2005).

Wagner (2010) collected 21st century skills under seven sub-categories such as critical thinking (CT) and problem solving which mean asking critical questions and being curious, collaboration across networks and leading by the influence which mean interacting around the globe with people from diverse cultures, religions and life-styles, agility and adaptability which mean being able to think, change, adapt quickly and use a variety of tools to solve new problems when required, initiative and entrepreneurialism which mean being self-directive and initiative to find some very tough and challenging problems, effective oral and written communication which mean the ability to effectively use language skills in both spoken language and writing in both printed and digital writing, accessing and analyzing information which mean being prepared to process the information effectively, and curiosity and imagination which mean coming up with creative solutions and being inquisitive even in analyzing. The numerous different frameworks for 21st century skills, in broad terms, illustrate three categories which are higher-order thinking skills such as CT and problem solving, social, emotional and civic skills such as communication and collaboration, and digital skills such as information and media literacy (Trilling & Fadel, 2009; Salas-Pilco, 2013).

CT is regarded as the primary element of 21st century learning (Trilling & Fadel, 2009). Although it has been assumed that CT is a new concept, it is a well-established idea that has just gained significance (Hersh, 2009). CT has been defined in a variety of ways. De-Young (2003) defined CT as the ability to detect a problem, identify critical information needed to solve the problem, recognize explicit and inexplicit assumptions, select reliable hypotheses, draw reasonable conclusions and justify the validity of inferences. According to Ennis (1987) CT is reasonable and reflective thinking that focuses on the decision of what to believe or to do. Its priority is to make the best rational decision possible. Furthermore, Ennis (1987) also identifies six main components of CT: focus, reason, inference, situation, clarification and overview. According to Baldwin et al. (2011), CT is the application of management knowledge to identify challenges, define viable actions, assess those actions and pursue a chosen course of action. One more definition from Lovelace, Eggers and Dyck (2016) nearly summarizes CT as assessing and evaluating situations and proposing courses of action. Considering the definitions, it can be said that CT is a complex process that requires individuals to use higher-order cognitive skills to information processing (Choy & Cheah, 2009).

It can be said that CT is expected at nearly by every school level (McPeck, 2016; Forawi, 2016). As Long et al. (2018) mentioned that it is important to make a successful transition to university and students must already have fundamental CT skills as university instructors frequently demand freshmen students to think critically. The widespread acceptance of the concept that strengthening students' CT is vital for academic achievement and will improve educational quality is the main motive behind this movement (Ren et al., 2020). However, high CT skills do not come naturally to people; rather, they must be actively cultivated (Paul & Binker, 1990). Silva (2009) argues that there is no specific age or developmental stage at which youngsters are ready to acquire sophisticated cognitive abilities. This contradicts the traditionally accepted belief that very young children are concrete and straightforward thinkers incapable of thinking abstractly or gaining a profound knowledge of concepts. For example by the age of seven they make rules to solve the issues among themselves, use the language including the words "think", "know", "guess" and "remember", hypothesize what could happen about future events, offer alternative acts, and suggest alternative actions that may have been performed before (Taggart et al. 2005). However, CT is such a tender matter that even the students have a disposition to CT, transferring CT skills to new contexts is unlikely unless students are specifically taught to transfer by sensitizing them to deep problem structures and provided with ample opportunities to practice CT skills in diverse domains (Lai, 2011).

Another major point about CT is whether CT instruction appeals to students' dispositions. CT is far more than using the right skill in the right context. It is also a disposition to recognize when a skill is required and being willing to exert the mental effort needed to apply it (Halpern, 1999). In the Delphi consensus panel of 46 experts, skills and dispositions were worth a small discussion. The Delphi panel maintained it was possible to have the cognitive skills required for CT but lack the emotional dispositions –general habits and attitudes–to put these talents to use. Hence, the panel held that developing both skills and dispositions was crucial in the education of successful critical thinkers (Facione, 1990b).

According to Facione and Gittens (2011), people with a strong favorable disposition toward CT are defined in the literature as "having a critical spirit", or as "mindful", "reflective" and "meta-cognitive." These phrases acknowledge a person's constant use of CT skills to whatever problem and question is at hand. However, with respect to approaching specific questions, issues, decisions and problems, people who have a weak or negative CT disposition are more likely to be impulsive, disorganized about gathering needed information, prone to applying unreasonable criteria, give up quickly at the first sign of difficulty, and fixated on a solution that will not operate.

When it comes to CT, a single skill or a description shouldn't come to mind. As there have been many descriptions of CT, there have also been various sub-skills of CT because CT is an integrated skill consisting of many sub-skills or sub-dimensions (Fisher, 2011). Watson and Glaser's (1994) sub-dimensions of CT are inference, recognition of assumptions, deductions, interpretation, and evaluation of arguments.

Jones et al.'s (1995) sub-dimensions are interpretation, analysis, evaluation, inference, presenting argument skills and reflection. While Facione (1990a) describes the sub-dimensions of CT as analysis, inference, evaluation, deductive reasoning and inductive reasoning using multiple choice items, Jonassen (2000) describes them as collecting the relevant knowledge, making logical inferences, reaching provable hypothesis, application of inferences in a sensible way, checking the consistency of knowledge.

When examining the studies on CT skills, it is striking that many researchers investigated the relationship between CT skills and other variants including demographic variables. It can be inferred that demographic variables are always on the agenda when considering CT skills. Previous literature on gender differences in CT skills reported conflicting results across various samples. Although some studies concluded CT skills did not significantly differ by gender (Sur, 2020; Saçlı & Demirhan, 2008; Özcan, 2017; Marni et al., 2020; Afhasi & Afghari, 2017), some studies reported a significant difference in favor of females (Irwanto, Rohaeti, & Prodjosantoso, 2019; Shubina & Kulaklı, 2019; Hove, 2011; İncirkuş, 2021; Ay & Akgöl, 2008) while some of them reported males have comparatively higher CT skills (Algharaibeh & ALmomani, 2020). Previous studies also revealed contradictory results on father, and mother's educational background differences in CT skills. While some studies concluded CT skills did not significantly differ by parents' educational background (Karademir & Saracaloğlu, 2017; Kavenuke, Kinyot, & Kayombo, 2020; Bulut, 2021), there are also other studies concluding CT skills significantly differed by father's educational background (Ocak & Kalender, 2016; Usta, 2019; Kıran, 2019) and mother's educational background (Ay & Akgöl, 2008; Bapoğlu, 2010; Kıran, 2019; Usta, 2019; Mete, 2021). Besides, when the existing literature on CT skills is investigated, inconsistent results were found over age differences in CT skills. While some studies concluded CT skills did not significantly differ by age (Wettstein et al., 2011), there are also other studies concluding CT skills significantly differed by age (Kürüm, 2002; Ay & Akgöl, 2008; Ludin, 2018). Also, although it can be found some studies concluded CT skills did not significantly differ by grade level (Profetto-McGrath, 2003; Gharib et al., 2009; Babamohamadi et al., 2016), there are also other studies that revealed CT skills significantly differed by grade level (Feng et al., 2010). In short, gender, parents' educational background, age, and grade level are widely examined demographic variables within the context of CT skills and the previous literature on CT skills revealed inconsistent results across different countries and samples. Besides, it has been observed that studies investigating the effect of demographic variables on CT skills are far more restricted than the studies investigating the relationship between demographic variables and CT dispositions. Therefore, this study aimed to determine the level of high school students' CT skills and whether these skills differ by some demographic variables. To this end, the following questions were sought:

1. What are the students' levels of CT skills?

2. Do high school students' CT skills significantly differ by their gender, father, and mother's educational background, age, and grade level?

2. METHOD

Research Model

A cross-sectional survey design was employed in this non-experimental quantitative study. The researchers collect data to draw inferences about a population at a specific point in time in cross-sectional survey designs (Lavrakas, 2008). In other words, it is aimed to depict what already exists in the population by examining the data collected from a group of participants at one point in time (Setia, 2016). This study aimed to investigate the level of high school students' CT skills and examine the possible demographic variables that can be related to CT skills. Therefore, a cross-sectional survey design was employed in this study.

Study Group

This current study was conducted with 603 students studying in various high schools in a city in the north of Turkey in the academic year of 2021-2022 using a convenient sampling method. The mean age of the students was 15.62 (SD=1.09) ranging from 14 to 17. The demographic characteristics of the study group can be seen in Table 1.

Table 1

Demographic characteristics of the study group

Demographics		n	%	Total
Gender	Female	343	56.9	603
	Male	260	43.1	
Educational background of mother	Primary school	161	26.7	603
	Elemantary school	116	19.2	
	High school	179	29.7	
	University	130	21.6	
	Master/PhD	17	2.8	
Educational background of father	Primary school	100	16.6	603
	Elemantary school	88	14.6	
	High school	194	32.2	
	University	188	31.2	
	Master/PhD	33	5.5	
Age	13	16	2.7	603
	14	116	19.2	
	15	144	23.9	
	16	160	26.5	
	17	159	26.4	
	18+	8	1.3	
Grade level	9	141	23.4	603
	10	149	24.7	

11	165	27.4
12	148	24.5

As it can be seen in Table 1, 343 of the students were female (56.9%) and 260 of them were male (43.1%). Most of the students had a mother with a high school (29.7%) and a primary school degree (26.7%). Besides, most of the students' fathers graduated from high school (32.2%) and university (31.2%). The majority of the students were 16 and 17 years old (52.9%). Also, 27.4%, 24.7%, 24.5%, and 23.4% of the students were studying at 11th grade, 10th grade, 12th grade, and 9th grade, respectively. Ethics committee approval for this study was obtained from the Human Research Ethics Committee of Zonguldak Bülent Ecevit University with the decision dated 29.05.2014 and numbered 2014/08-13.

Data Collection Tools

Critical Thinking Skill Test for High School Students (CTST)

CTST was used to investigate students' CT skills in this study because CTST is a Turkish culture-specific CT test aiming to measure high school students' CT skills and it has satisfactory psychometric properties as discussed below. CTST developed by (Orhan & Çeviker Ay, 2022) has 51 multiple-choice items and is composed of five sub-tests which are inference (10 items), evaluating arguments (8 items), deduction (11 items), recognizing assumptions (12 items) and interpretation (10 items). Reliability and validity studies of CTST were carried out with 705 high school students. While mean item difficulty values of the sub-tests ranged from 0.51 to 0.63, mean item discrimination values varied between 0.35 and 0.49. Also, mean item difficulty value of the total test was calculated as 0.52 and mean item discrimination value of the total test was found to be 0.42. Besides, KR20 reliability estimates for the sub-tests ranged from 0.62 to 0.75 and it was calculated as 0.87 for the total test. In this study, reliability estimates were calculated again and they ranged from 0.54 to 0.75. A score for the total test between 0-17, between 18-35, and between 36-51 indicates low, moderate, and high CT skill, respectively.

Data Collection

The ethical committee approval was obtained from Zonguldak Bülent Ecevit University (No. 117010 dated 31.12.2021) and the data were collected in 2021-2022 academic year. Students were informed about privacy and confidentiality issues and their right to withdraw from the study whenever they want. It took about 40-45 minutes to complete the test.

Data Analysis

SPSS 20 statistical software was used to analyze the collected data. Firstly, each variable was reviewed to check if there are any missing data and no missing data were observed. Then, normality was investigated with skewness and kurtosis values. In order to say that the data are normally distributed, the z values obtained by dividing the skewness and kurtosis values by their own standard errors should be between +2 and -2 (Tabachnick & Fidell, 2012; Lind, Marchal & Wathen, 2012). After investigating skewness and kurtosis values, it was seen that the data were not normally distributed (see Table 2). Therefore, descriptive statistics, Mann-Whitney U, and Kruskal-Wallis H tests were used to analyze the data.

3. FINDINGS

Descriptive statistics for all sub-tests of the CTST and total test scores are presented in Table 2 below.

Table 2

Descriptive statistics for the CTST

Sub-tests	Skewness		Kurtois		Maximum Point	$\bar{X}$	sd
	Statistic	Std. Eror	Statistic	Std. Eror			
Inference	-0.738	0.100	-0.021	0.199	10	7.47	1.90
Evaluating arguments	-2.056	0.100	4.182	0.199	8	7.53	0.84
Deduction	-1.713	0.100	4.089	0.199	11	9.36	1.65
Recognizing assumptions	-0.995	0.100	0.974	0.199	12	10.50	1.30
Interpretation	-1.433	0.100	2.127	0.199	10	7.95	2.03
Total	-1.064	0.100	1.301	0.199	51	42.83	4.86

As shown in Table 2, high school students had high scores for inference ($\bar{X}$=7.47), evaluating arguments ($\bar{X}$=7.53), deduction ($\bar{X}$=9.36), recognizing assumptions ($\bar{X}$=10.50), and interpretation ($\bar{X}$=7.95) sub-tests. Therefore, it can be said that students have high CT skills in terms of these sub-dimensions. Also, the mean of the students' total scores was high ($\bar{X}$=42.83) indicating they have high CT skills.

Table 3

Mann-Whitney U Test Results by Gender

	Gender	n	Mean Rank	Sum of Ranks	U	p	*d*
Inference sub-test	Male	260	285.34	74188.50	40258.50	0.03	0.16
	Female	343	314.63	107917.50			
	Gender	n	Mean Rank	Sum of Ranks	U	p	*d*
Evaluating arguments sub-test	Male	260	268.49	69806.50	35876.50	0.00	0.34
	Female	343	327.40	112299.50			
	Gender	n	Mean Rank	Sum of Ranks	U	p	*d*
Deduction sub-test	Male	260	283.18	73626.00	39696.00	0.01	0.18
	Female	343	316.27	108480.00			
	Gender	n	Mean Rank	Sum of Ranks	U	p	*d*
Recognizing assumptions sub-test	Male	260	263.71	68564.00	34634.00	0.00	0.39
	Female	343	331.03	113542.00			
	Gender	n	Mean Rank	Sum of Ranks	U	p	*d*
Interpretation sub-test	Male	260	252.57	65668.00	31738.00	0.00	0.51
	Female	343	339.47	116438.00			
	Gender	n	Mean Rank	Sum of Ranks	U	p	*d*
Total test	Male	260	247.73	64410.00	30480.00	0.00	0.56
	Female	343	343.14	117696.00			

As it can be seen in Table 3, Mann Whitney-U test results indicated that there was a statistically significant difference between inference (U=40258.50; $p<0.05$), evaluating arguments (U=35876.50; p<0.05), deduction (U=39696.00; p<0.05), recognizing assumptions (U=34634.00; p<0.05), and interpretations (U=31738.00; p<0.05) sub-tests scores of male and female students. Also, it was found that gender was a significant variable on students' total CT skills (U=30480.00; p<0.05). Female students had higher CT skills in terms of both each sub-test and total test. While gender had a weak effect on students' inference (*d*=0.16) and deduction (*d*=0.18) skills, it had small effect on their evaluating arguments (*d*=0.34) and recognizing assumptions (*d*=0.39) skills based on Cohen's (1988) classification. Besides, gender had a medium effect on students' interpretation (*d*=0.51) and total CT skills (*d*=0.56) based on Cohen's (1988) classification.

Table 4

Kruskal-Wallis H test results by educational background of mother

		Inference sub-test						Evaluating arguments sub-test					
	n	Mean Rank	X^2	df	p	η^2	Sig. Differ.	Mean Rank	X^2	df	p	η^2	Sig. Differ.
A	161	267.67						320.03					
B	116	262.67						297.02					
C	179	311.77	30.06	4	0.00	0.04	D-B D-A	295.11	5.161	4	0.27	-	-
D	130	363.56						299.71					
E	17	321.94						255.26					
		Deduction sub-test						Recognizing assumptions sub-test					
	n	Mean Rank	X^2	df	p	η^2	Sig. Differ.	Mean Rank	X^2	df	p	η^2	Sig. Differ.
A	161	273.49						279.84					
B	116	270.28						283.30					
C	179	320.39	18.05	4	0.00	0.02	D-A	327.78	9.301	4	0.05	-	-
D	130	330.05						305.83					
E	17	380.41						338.71					
		Interpretation sub-test						Total test					
	n	Mean Rank	X^2	df	p	η^2	Sig. Differ.	Mean Rank	X^2	df	p	η^2	Sig. Differ.
A	161	283.79						264.75					C-B
B	116	269.57	11.90	4	0.01	0.01	D-B	258.06	29.88	4	0.00	0.04	D-B
C	179	313.85						322.17					C-A
D	130	331.24						353.68					D-A

E	17	347.32						347.09					

A=primary school B=elementary school C=high school D=university E=master/PhD

According to Kruskal-Wallis H test results in Table 4, students' inference ($X^2_{(sd=4, n=603)}=30.06$; $p<0.05$), deduction ($X^2_{(sd=4, n=603)}=18.05$; $p<0.05$), interpretation ($X^2_{(sd=4, n=603)}=11.90$; $p<0.05$) sub-tests and total test ($X^2_{(sd=4, n=603)}=29.88$; $p<0.05$) scores significantly differed by educational background of students' mother. However, their evaluating arguments ($X^2_{(sd=4, n=603)}=5.161$; $p>0.05$) and recognizing assumptions ($X^2_{(sd=4, n=603)}=9.301$; $p>0.05$) sub-tests scores did not significantly differ by educational background of students' mother. Students whose mother has a bachelor's degree had higher inference sub-test scores than the students whose mothers completed only primary and elementary school. Also, the students who have a mother with a bachelor's degree had higher deduction sub-test scores than those whose mother completed only primary school. Besides, students whose mother has a bachelor's degree had higher interpretation sub-test scores than those whose mothers completed only elementary school. In addition to these, students who have a mother with a bachelor's degree and high school degree had higher total CT test scores than the students whose mother completed only primary and elementary school. While the educational background of students' mothers had a small effect on their deduction ($\eta^2=0.02$), interpretation ($\eta^2=0.01$) skills, it had a medium effect on their inference ($\eta^2=0.04$) and total CT skills ($\eta^2=0.04$) based on Cohen's (1988) classification.

Table 5

Kruskal-Wallis H test results by educational background of father

		Inference sub-test						Evaluating arguments sub-test					
	n	Mean Rank	X^2	df	p	η^2	Sig. Differ.	Mean Rank	X^2	df	p	η^2	Sig. Differ.
A	100	238.63					C-A	292.46					
B	88	243.30					D-A	324.05					
C	194	309.61	39.93	4	0.00	0.06	E-A	304.17	4.245	4	0.37	-	-
D	188	345.33					C-B	299.79					
							D-B						
E	33	358.98					E-B	271.95					
		Deduction sub-test						Recognizing assumptions sub-test					
	n	Mean Rank	X^2	df	p	η^2	Sig. Differ.	Mean Rank	X^2	df	p	η^2	Sig. Differ.
A	100	261.81	23.97	4	0.00	0.03	D-B	268.02	13.77	4	0.00	0.02	C-B
B	88	248.53					E-B	260.85					D-B

C	194	308.63					D-A	317.84					
D	188	332.59						317.60					
E	33	353.12						332.74					
		Interpretation sub-test						Total test					
	n	Mean Rank	X^2	df	p	η^2	Sig. Differ.	Mean Rank	X^2	df	p	η^2	Sig. Differ.
A	100	263.08						237.65					
B	88	268.01						236.44					
C	194	336.41	16.65	4	0.00	0.02	C-A C-B	326.47	38.45	4	0.00	0.06	C-B D-B C-A D-A
D	188	301.74						336.41					
E	33	309.77						331.94					
A=primary school B=elementary school C=high school D=university E=master/PhD													

As it can be seen in Table 5, students' inference ($X^2_{(sd=4,\ n=603)}=39.93$; $p<0.05$), deduction ($X^2_{(sd=4,\ n=603)}=23.97$; $p<0.05$), recognizing assumptions ($X^2_{(sd=4,\ n=603)}=13.77$; $p<0.05$), interpretation ($X^2_{(sd=4,\ n=603)}=16.65$; $p<0.05$) sub-tests and total test ($X^2_{(sd=4,\ n=603)}=38.45$; $p<0.05$) scores significantly differed by educational background of the students' fathers. However, their evaluating arguments ($X^2_{(sd=4,\ n=603)}=4.245$; $p>0.05$) sub-test scores did not significantly differ by educational background of students' father. Students who have a father with high school, bachelor's, and master/PhD degree had higher inference sub-test scores than those whose fathers completed only primary and elementary school. Also, the students who have a father with a bachelor's and master/PhD degree had higher deduction sub-test scores than the students whose fathers completed only elementary school. In addition to this, students whose fathers have a bachelor's degree had higher deduction sub-test scores than those whose fathers completed only primary school. Besides, students who have a father with high school and bachelor's degree had higher recognizing assumptions sub-test scores than the students whose father completed only elementary school. In addition to this, students whose fathers completed high school had higher interpretation sub-test scores than the students whose fathers completed only primary and elementary school. Also, students who have a father with a high school and bachelor's degree had higher total CT test scores than the students whose father completed only primary and elementary school. While the educational background of students' fathers had a small effect on their deduction ($\eta^2=0.03$), recognizing assumptions ($\eta^2=0.02$), and interpretation ($\eta^2=0.02$) skills, it had a strong effect on their inference ($\eta^2=0.06$) and total CT skills ($\eta^2=0.06$) based on Cohen's (1988) classification.

Table 6

Kruskal-Wallis H test results by age

		Inference sub-test						Evaluating arguments sub-test					
	n	Mean Rank	X^2	df	p	η^2	Sig. Differ.	Mean Rank	X^2	df	p	η^2	Sig. Differ.
14	122	328.57	3.813	3	0.28	-	-	298.56	2.697	3	0.44	-	-
15	150	290.92						315.73					
16	166	296.36						303.80					
17	165	298.10						290.25					
		Deduction sub-test						Recognizing assumptions sub-test					
	n	Mean Rank	X^2	df	p	η^2	Sig. Differ.	Mean Rank	X^2	df	p	η^2	Sig. Differ.
14	122	321.33	3.532	3	0.31	-	-	282.45	2.553	3	0.46	-	-
15	150	303.74						300.91					
16	166	283.99						313.89					
17	165	304.24						305.49					
		Interpretation sub-test						Total test					
	n	Mean Rank	X^2	df	p	η^2	Sig. Differ.	Mean Rank	X^2	df	p	η^2	Sig. Differ.
14	122	329.20	7.419	3	0.06	-	-	319.80	2.884	3	0.41	-	-
15	150	276.77						285.47					
16	166	312.84						307.55					
17	165	293.91						298.29					

According to Kruskal-Wallis H test results in Table 6, students' inference ($X^2_{(sd=3,\ n=603)}=3.813$; $p>0.05$), evaluating arguments ($X^2_{(sd=3,\ n=603)}=2.697$; $p>0.05$), deduction ($X^2_{(sd=3,\ n=603)}=3.532$; $p>0.05$), recognizing assumptions ($X^2_{(sd=3,\ n=603)}=2.553$; $p>0.05$), interpretation ($X^2_{(sd=3,\ n=603)}=7.419$; $p>0.05$) sub-tests and total test ($X^2_{(sd=3,\ n=603)}=2.884$; $p>0.05$) scores did not significantly differ by students' age.

Table 7

Kruskal-Wallis H test results by grade level

		Inference sub-test						Evaluating arguments sub-test					
	n	Mean Rank	X^2	df	p	η^2	Sig. Differ.	Mean Rank	X^2	df	p	η^2	Sig. Differ.
1st g.	141	320.77						300.26					
2nd g.	149	277.54	5.144	3	0.16	-	-	306.59	0.784	3	0.85	-	-
3rd g.	165	310.41						294.92					
4th g.	148	299.36						306.92					
		Deduction sub-test						Recognizing assumptions sub-test					
	n	Mean Rank	X^2	df	p	η^2	Sig. Differ.	Mean Rank	X^2	df	p	η^2	Sig. Differ.
1st g.	141	314.95						280.96					
2nd g.	149	292.12	2.008	3	0.57	-	-	303.43	3.488	3	0.32	-	-
3rd g.	165	293.55						316.63					
4th g.	148	309.02						304.30					
		Interpretation sub-test						Total test					
	n	Mean Rank	X^2	df	p	η^2	Sig. Differ.	Mean Rank	X^2	df	p	η^2	Sig. Differ.
1st g.	141	313.97						313.48					
2nd g.	149	273.29	7.404	3	0.06	-	-	270.96	6.687	3	0.08	-	-
3rd g.	165	322.38						317.16					
4th g.	148	296.78						305.41					

1st g.=1st grade, 2nd g.=1nd grade, 3rd g.=3rd grade, 4th g.=4th grade

As it can be seen in Table 7, students' inference ($X^2_{(sd=3,\ n=603)}=5.144$; $p>0.05$), evaluating arguments ($X^2_{(sd=3,\ n=603)}=0.784$; $p>0.05$), deduction ($X^2_{(sd=3,\ n=603)}=2.008$; $p>0.05$), recognizing assumptions ($X^2_{(sd=3,\ n=603)}=3.488$; $p>0.05$), interpretation ($X^2_{(sd=3,\ n=603)}=7.404$; $p>0.05$) sub-tests and total test ($X^2_{(sd=3,\ n=603)}=6.687$; $p>0.05$) scores did not significantly differ by students' grade level.

4. RESULTS, DISCUSSION, AND SUGGESTIONS

This study simed to determine the level of high school students' CT skills and whether these skills differ by some demographic variables. The results of this study revealed that students had high scores in terms of all CTST sub-tests and total test. Therefore, we can say that students had high CT skills in terms of each sub-dimensions. Although the majority of the previous studies revealed that students had high CT skills (Sur, 2020; Usta, 2019; Karademir & Saracaloğlu, 2017; Yıldırım & Şensoy, 2011), there are also other studies which concluded that students had moderately high CT skills (Mete, 2021; Bölükbaşoğlu, 2021; Yavuz, 2019; Ocak & Kalender, 2016). Therefore, we can say that most of the previous studies concluded that students from different school levels had either high or moderately high CT skills.

It was found that while gender significantly affected students' inference and deduction skills with a weak effect, it significantly affected their evaluating arguments and recognizing assumptions skills with a small effect. Besides, gender significantly affected students' interpretation and total CT skills with a medium effect. Female students had higher CT skills in terms of both each sub-test and total test. This result matches with the results of the researchers who found females' CT skills are higher than males (Irwanto, Rohaeti, & Prodjosantoso, 2019; Ayaz, 2012; Altay, 2013; Kıran, 2019; Shubina & Kulaklı, 2019; Hove, 2011). However, there are also other studies that revealed contradictory results on gender differences in CT skills. While some studies reported no significant difference by gender (Afsahi & Afghari, 2017; Özcan, 2017; Sur 2020), some studies concluded that males were ahead when compared to female students in CT skills (King, Wood, & Mines, 1990; Thayer-Bacon, 1993; Algharaibeh & ALmomani, 2020; Marni et al., 2020). Some researchers attributed females' success in CT to females' being more able to think critically and to arrange the way of their thinking than those of males. For example, depending on the explanations of many researchers, Hayati and Berlianti (2020) said that females are more careful and meticulous about re-examining what they have done and have better debating skills when compared to males. They also mentioned that female students ask questions more accurately and credibly than males, implying that female students have superior CT abilities than male students. Some researchers attributed gender effect to brain processing types saying male brains tend to grow and have more sophisticated spatial abilities, such as mechanism planning, measuring, direction determination, abstraction, and physical manipulation. The cortical region of the male brain is primarily focused on spatial tasks, with only a small fraction dedicated to producing and processing words. Moreover, the ability to estimate the causes of the problems for males is easier as it is also related to the left side of the brain on which CT skills is higher compared to the right side of the brain used generally by females (Fuad et al., 2017; Algharaibeh & ALmomani, 2020; Marni et al., 2020). Besides these, considering the CT skills tests and their sub-dimensions, gender effect also varies from test to test in general and from one sub-dimension to another. These tests must be performed on miscellaneous groups to get better inferences about gender effect. So, this could also be another factor that makes us think that gender may not be a determinant variant for now.

Also, this study concluded that while students' inference, deduction, interpretation sub-tests and total test scores significantly differed by educational background of students' mothers, their evaluating arguments and recognizing assumptions sub-tests scores did not significantly differ by educational background of students' mothers. While the educational background of students' mothers had a small effect on their deduction and interpretation skills, it had a medium effect on their inference and total CT skills. Besides, it was found out that students who have a mother with higher educational degrees had also higher CT skills. This result is in line with many previous studies (Ay & Akgöl, 2008; Bapoğlu, 2010; Kıran, 2019; Usta, 2019; Mete, 2021). However, the present study differs from some other studies that concluded parents' educational background had no significant effect on CT skills (Gülveren, 2007; Karademir & Saracaloğlu, 2017; Kavenuke, Kinyot, & Kayombo, 2020; Bulut, 2021).

According to another result obtained from the study, while students' inference, deduction, recognizing assumptions, interpretation sub-tests and total test scores significantly differed by educational background of students' fathers, their evaluating arguments sub-test scores did not significantly differ by the educational background of their fathers. While the educational background of students' fathers had a small effect on their deduction, recognizing assumptions, and interpretation skills, it had a strong effect on their inference and total CT skills. Also, it was found that students who have a father with higher educational degrees had also higher CT skills. This result is in line with many previous studies (Ocak & Kalender, 2016; Usta, 2019; Kıran, 2019). However, there are also some other studies revealed that fathers' educational background did not have a significant effect on students' CT skills (Bakan, 2010; Görücü, 2014; Yüksekbilgili, 2019).

In short, it can be said that most of the previous studies, including this one, revealed that the educational background of students' fathers and mothers was a significant variable that affects students' CT skills. The effect of parents' educational background on students' CT skills may be explained by Hortaçsu's (1995) specification. Since women are primarily responsible for childrearing in Turkey, it can be said that mothers with higher levels of education can tutor and supervise their children better when compared to mothers with lower levels of education. Rearing is regarded as one of the many factors that contribute to the improvement of CT skills and to which parents should pay more attention (Huang et al., 2015). Based on this point of view, we can say the same specification for fathers in this era. So, it can be said for both of the parents that the higher education level of parents, the more they can provide support, guidance in social and cultural environments and ask their children Socratic questions as Socratic questioning is one of the most effective teaching methods for leading students to produce insightful questions that will improve their CT skills (Yang, 2008). Parents being together with students in social environments may also develop students' collaborative learning skills which also have effects on the development of CT skills (Sulisworo & Syarif, 2018; Kusumawati, Hobri, & Hadi, 2019). Besides, it can be inferred that as well-educated parents have been to so many different learning environments including university, they may have carefully observed their children's needs for thinking critically and put some more emphasis on the development of this inadequacy on the spot. Also, parents with higher education are more likely to communicate and use more complex language with their children and to participate in extracurricular school developmental activities (Eccles, 2005). Using complex language and language proficiency could affect critical evaluation (Manalo & Sheppard, 2016) and extracurricular activities may improve students' CT skills through cooperative activities (Han & Kwon, 2018).

This study revealed that students' age and grade level did not significantly affect students' each sub-test scores and total test scores. Therefore, it can be said that age and grade level was not a significant variable that affects students' CT skills. When the relevant literature is examined, some studies concluded age (Azizi-Fini, Hajibagheri, & Adib-Hajbaghery, 2015; Wettstein et al., 2011; Soeherman, 2010) and grade level (Profetto-McGrath, 2003; Gharib et al., 2009; Babamohamadi et al., 2016) did not have a significant effect on CT skills can be found. Therefore, these two results of this study are confirmed by previous literature. However, there are also some other studies revealed that age (Kürüm, 2002; Ay & Akgöl, 2008; Ludin, 2018) and grade level (Feng et al., 2010) had a significant effect on students' CT skills. Repo et al. (2017) stated that it might be arguable that one's level of life experience does not affect the development of CT skills. Furthermore, there being no difference between age and grade level of students in high school might also be attributed to lack of activities promoting CT in the official high school curricula and the absence of thought provoking and exciting resources arousing students' curiosity and inquisitiveness in Turkey. As a result, this issue should be thoroughly examined, and some steps should be taken to ensure that the development of CT skills is strongly and effectively encouraged at the end of high school, particularly since some students graduating from high schools enter the universities in which CT skills are far more required.

In short, this study revealed that while CT skills significantly differed by students' gender and educational background of students' mothers and fathers, they did not significantly differ by students' age and grade level. Although previous literature on gender, educational background of students' mothers and fathers, age, and grade level differences in CT skills reported conflicting results across various samples, these results of the current study were confirmed by the huge body of previous literature. Besides, it was seen that gender and the educational background of students' mothers and fathers were the most investigated demographic variables and there are relatively less studies investigating age and grade level differences on CT skills.

Limitations and Recommendations

Although this study is important to shed light on the effect of demographic variables on high school students' CT skills, it has several limitations. Sample of the study can be seen as the first limitation of the study as it was carried out with high school students in northern of Turkey. Second, there may be other demographic variables that were not considered in this study. Third, we can say that this study is limited in terms of data collection tools since only quantitative tools were used to collect the data.

The results of this study have important implications. It would be a good idea to investigate the effect of demographic variables on CT skills with a sample consisting of students from different educational levels and compare the results with this study. Also, qualitative or mixed methods may be employed in future studies to provide a further understanding of the effect of demographic variables on CT skills.

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