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THE EFFECTS OF LIFELONG LEARNING TENDENCIES ON CRITICAL THINKING AND COMPUTATIONAL THINKING SKILLS[1]

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ABSTRACT

It is aimed to examine the effects of computational thinking skills and critical thinking skills of students enrolled in the pedagogical formation certificate program, which is considered within the scope of lifelong learning in education faculties, on lifelong learning skills in this study. Scanning model principles were taken into account in order to achieve the aim. Structural regression analysis was used to test the relationship between variables in the study. The data were collected from 240 students who are continuing the pedagogical formation certificate program, which is based on lifelong learning. The Critical Thinking Scale (CT), Computational Thinking Self-Efficacy Scale (CoT) and The Lifelong Learning Tendency Scale (LLL) were used to collect the data. According to the results, CoT has a direct and significant effect on CT at the rate of 84%, and the CoT directly explains LLL at a rate of 59%.

Keywords: Critical Thinking, Lifelong Learning, Computational Thinking

1. INTRODUCTION

The rapid developments in the field of information and communication and the rapid transformations of our world reveal the trust in information and the importance of information day by day. With the help of technologies developed in the field of information and communication, information is shared more quickly and easily and today's information society is formed. For this reason, individuals who are needed in the information society, who can adapt rapidly to changing technology, who can constantly renew themselves, who have the ability to think analytically and question (critical thinking), should be raised [1]. The determination of the individuals who make up the society to acquire the information that is constantly being added and in this context to renew themselves can be achieved by integrating learning into their lives, in short, by aiming for lifelong development.

It is seen that the lifelong learning approach was adopted as an educational discourse in Lisbon 2000, when European countries demonstrated the necessity of a knowledge-based economy [2-5]. In this context, lifelong learning includes the ability to access, use and evaluate the necessary information from various sources in order to adapt to the rapidly changing economic, political, cultural and technological environment. According to Atkainen (2001), lifelong learning is not only a learning that continues throughout our lives, but also a learning that spreads to all areas of life and lasts "from the cradle to the grave" [6].

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Life-long learning [7, 8] involves training in the network in such a way that it can be continually learned from tasks that emerge sequentially and be added to its existing knowledge base instead of replacing knowledge about the older tasks. Lifelong learning competencies have been handled by the European Commission under 8 basic dimensions. In general, 21st-century skills include collaboration, communication, digital literacy, citizenship, problem solving, critical thinking, creativity and productivity [9].

Being aware of one's learning processes and needs, identifying appropriate opportunities, and overcoming obstacles in order to be successful in the lifelong learning process are closely related to learning how to acquire skills [10]. In this context, it is necessary to examine the relationship between lifelong learning and the basic skills that individuals need to learn in the century we live in. Looking at the competencies of lifelong learning, it is seen that these competencies also include 21st century skills. 21st century skills cover basic skill areas such as problem solving, critical thinking and decision making, communication and cooperation, information literacy, technology literacy, flexibility and adaptability, global competencies and financial literacy [11].

The development of critical thinking in students is the basis for their development in society as professionals who own the skills of entrepreneurship, inquisition, creativity, and are able to correctly assess their behavior, have their own ideas, views, build and raise the foundation of our great future. [12]. Critical thinking is a process of thought which is based on drawing conclusions by deciding, relevant data, including analysis, explaining, hypothesis, arguing, and developing thinking [13]. Acquiring critical thinking helps individuals interact with other individuals with an independent, creative, scientific perspective, helps them evaluate events holistically, and helps them define the parameters, criteria and requirements they need in decision-making processes in social life. Critical thinking is not an innate feature, but a system that can be taught, explained and easily applied [11, 12].

Homayounzadeh (2015) has revealed that critical thinking in the higher education process is one of the most important determinants in the development of lifelong learning [14]. Green (2015) states that the acquisition of critical thinking skills will have a positive effect on lifelong learning [15]. In their study, Deveci and Ayish (2017) found a weak positive relationship between critical thinking and lifelong learning scores of students who have just started university [16]. Wei (2020) stated that the impact of critical thinking on lifelong learning should be re-evaluated in today's changing world [17].

Today, the problematic situations that individuals need to solve require them to actively integrate mathematical thinking processes into their lives. Computational thinking which has an important place in these thinking processes is considered as a skill that 21st-century individuals should acquire and utilize efficiently in solving the problems with which they are faced in real life. The International Society for Technology in Education (ISTE) has indicated that algorithmic and arithmetic thinking has had an influence on the CT concept and has identified CT as one of the learner characteristics in the 21st century [18].

Computational thinking is defined, which undertakes the main task among 21st century skills as abstract thinking and problem solving skills that can be used in daily life; “a thought process that involves formulating problems and their solutions in order to present solutions in a form that can be implemented effectively by an information processing unit.” [18-20].

Computational thinking is stated that it intersects with thinking skills such as algorithmic thinking, design thinking, and mathematical thinking at some points, and it also has a structure that can contribute to these thinking skills [21]. Computational thinking skill has a much wider scope, although it has computer-related connotations at first due to its name. When the working systems of computers are considered as the problem solving system of people in daily life, it is suggested that everyone should have this skill, not just those involved with computers [22, 23]. It has been discussed in many studies that the acquisition of computational thinking skills is an important necessity because it has a serious effect on problem solving strategies [22-26].

When the definition of computational thinking is examined in detail, it is thought that it may have an impact on lifelong learning, both because it systematically gains problem solving skills and because it contributes to many thinking skills such as algorithmic thinking, design thinking, and mathematical thinking. In this regard, Durak and Şahin (2018), in their study to determine the contribution of programming education to the development of lifelong learning competencies of pre-service teachers, found that programming teaching practices have an important effect on the development of lifelong learning competencies of prospective teachers and that programming teaching practices to increase the lifelong learning competencies of prospective teachers. showed that education could be a solution [27]. In addition, the aim of the "Lifelong Kindergarten" working group within MIT (Massachussets Institute of Technology School of Architecture and Planning) is to improve the creativity and productivity of students with the help of their computing skills [28]. In addition, considering lifelong learning competencies in today's world where technology is so rapidly integrated into our lives; it is also very important for individuals to use their computational thinking skills actively [29].

In the literature, it has been emphasized that higher education institutions are important in raising individuals with the necessary knowledge and skills for lifelong learning, and it has been stated that lifelong learning is an integral part of higher education. Göksan, Uzundurukan and Keskin (2009) emphasized the role of universities in raising individuals who can think critically, solve problems, make independent decisions and have lifelong learning skills in the information age [30]. In this context, Zuparic (2009) stated that higher education institutions have significant impact on individuals' acquiring lifelong learning by emphasizing their research tasks and following the most up-to-date information [31]. Dinevski and Dinevski (2004) on the other hand, the role of higher education institutions in lifelong learning; It is defined as the dissemination of knowledge through ways such as e-learning, virtual university, and internet-based education that provide professional development opportunities [32]. Çakın (1998) stated that universities should not be institutions where current knowledge is taught with a strict discipline, but places where it is aimed to gain the skills of questioning, encouraging creativity and continuous learning [33]. Soran, Akkoyunlu and Kavak (2006) stated that after the 1950s, the community services function was added to the teaching and research functions of universities and stated that universities have an important role in gaining lifelong learning skills [34]. In their study, Cendon (2018) revealed that digitalization in higher education has a positive effect on lifelong learning, as it provides a more flexible learning environment [35]. Starting from this point, it can be concluded that it is very important to examine the effect of critical thinking and computational thinking skills, which are considered within the competencies, on lifelong learning. In this context; the aim of the research is to examine the effects of computational thinking skills and critical thinking skills of pedagogical formation students, who are considered within the scope of lifelong learning in education faculties, on lifelong learning skills. Accordingly, the importance of the study could be explained as follows:

- *Current,* in terms of considering computational thinking and critical thinking skills, which are 21st century skills within the context of lifelong learning,
- *Original,* in that it examines the effects of computational thinking and critical thinking skills in lifelong learning within the scope of structural equation model for students studying in the pedagogical formation and certificate program,
-*Necessary,* in order to address 21st century skills within the scope of a program suitable for the nature of lifelong learning,
-*Functional,* in terms of guiding educational activities that can be done by exploring the effect of students' computational thinking and critical thinking skills in lifelong learning.

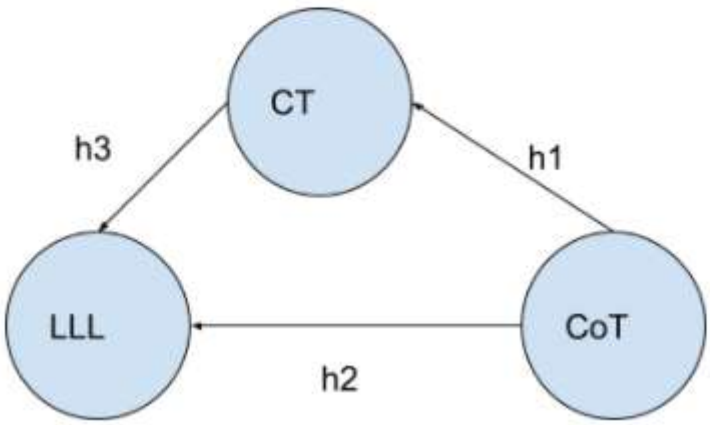
Based on these, the problem and sub-problem statements of the research are as follows:

“What is the mediating effect of critical thinking skill in the relationship between lifelong learning tendency and computational thinking skill?”

a) Is there a relationship between computational thinking and lifelong learning? If so, in what direction? (Does computational thinking have an effect on lifelong learning?)
b) Is there a relationship between critical thinking and lifelong learning? If so, in what direction? (Does critical thinking have an effect on lifelong learning?)
c) Is there a relationship between computational thinking and critical thinking? If so, in what direction? (Do computational thinking and critical thinking have an effect on each other?)

2. METHOD

In this study, it is aimed to examine the effects of computational thinking skills and critical thinking skills of students enrolled in the pedagogical formation certificate program, which is considered within the scope of lifelong learning in education faculties, on lifelong learning skills. In order to achieve the aim of the study, the scanning model principles were taken into account; accordingly, in the study, it is possible to describe the current situation by taking a photograph [36]. Fraenkel and Wallen (2006) state that screening studies are more important than the reasons for the opinions and characteristics obtained in the study, without an effort to change and influence an existing situation, but how the study group is dispersed [37]. This study was planned and conducted as an example of the relational screening model; structural regression analysis was used to test the relationship between variables in the study. The tested model is shown in Figure 1.



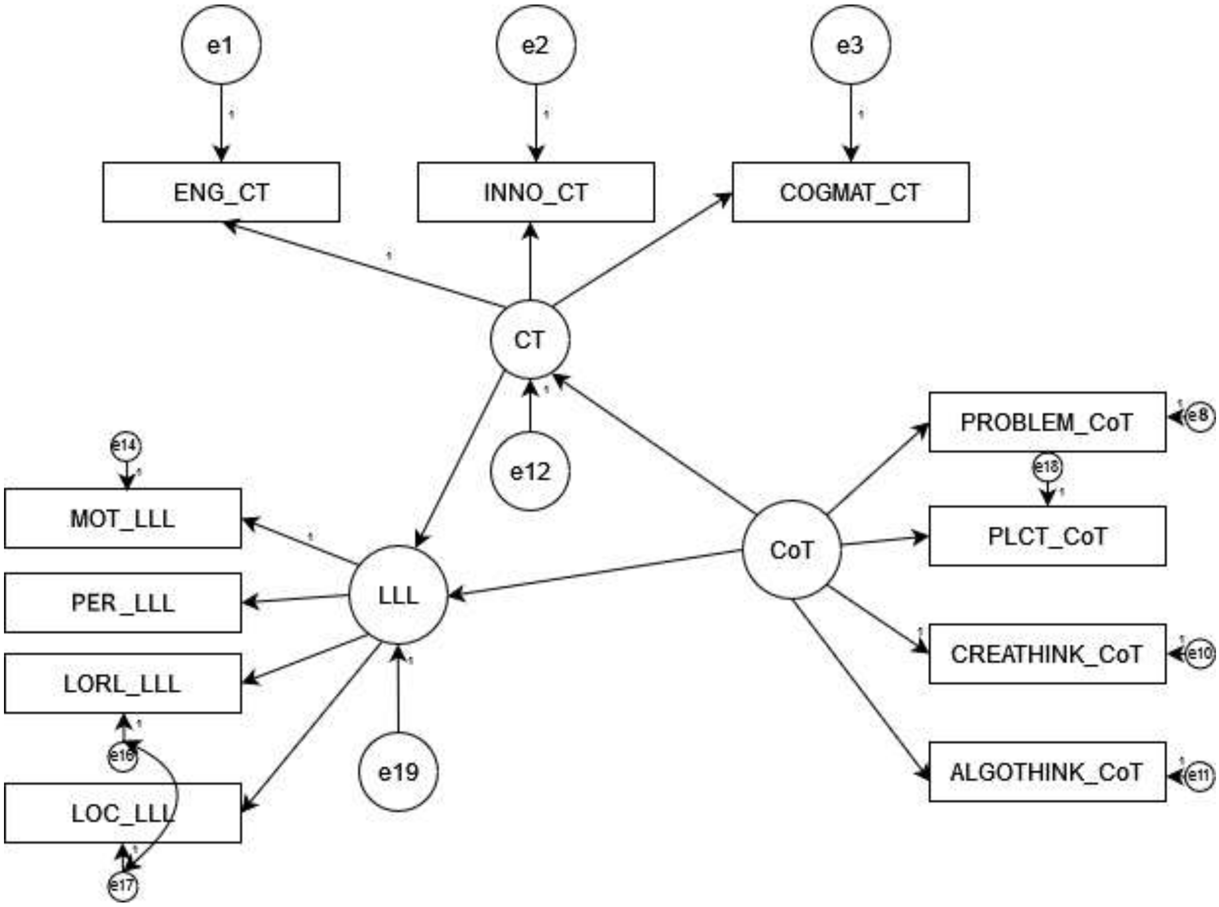


Figure 1. Structural regression model

2.1. Data Collection Tool

The data were collected face to face on a voluntary basis after obtaining the necessary permissions from the University. Three measurement tools were used to collect the data. Information on measurement tools is given below.

2.1.1. Critical thinking scale-cts

CTS, which was tried to be developed with different international researchers, was used in this study as it was developed by Friedel, Irani, Rhoades, Fuhrman, and Gallo (2008) and adapted into Turkish by Kılıç and Şen (2014) [38, 39]. The Critical Thinking Scale consists of three sub-dimensions as engagement, cognitive maturity and innovativeness and a total of 25 items. "I look for opportunities to solve problems." While the item is an example item for the engagement sub-dimension; "I listen carefully to the opinions of others, even if they disagree with me." item on the cognitive maturity sub-dimension and "I like to learn about many subjects." item is an example of the innovativeness sub-dimension. The scale has a 5-point Likert type structure and is evaluated as "1-Strongly Disagree", "2-Disagree", "3-Undecided", "4-Agree" and "5-Strongly Agree". According to the results of confirmatory factor analysis in which the factor structure was tested, it shows that the scale has acceptable and perfect fit indices. Finally, the internal consistency coefficient of the scale determined by Cronbach's Alpha was 0.91 for the whole; 0.88 for the engagement sub-dimension; 0.70 for cognitive maturity sub-dimension; It was reported as 0.73 for the innovativeness sub-dimension.

2.1.2. Computational thinking self-efficacy scale

Computational Thinking Self-Efficacy Scale developed by Yağcı (2019) consists of four sub-dimensions: problem solving, peer learning and critical thinking, creative thinking, and algorithmic thinking, and a total of 42 items [40]. “I can usually finish a given task on time.” item is an example of problem solving, “Trying to understand different views for solving a problem is a waste of time.” Item is an example of peer learning and critical thinking, “I strive to find a more effective solution to a problem.” thinking creatively and “After I finish a task, I ask myself if there is an easier way to do it.” item is also an example of the sub-dimensions of algorithmic thinking. The scale has a 5-point Likert type structure and is evaluated as "1-Strongly Disagree", "2-Disagree", "3-Undecided", "4-Agree" and "5-Strongly Agree". The obtained fit indices of the scale are in the range of excellent and acceptable values. Internal consistency coefficients for the sub-dimensions of the scale; .96 for problem solving, .94 for peer learning and critical thinking, .94 for creative thinking, and .83 for algorithmic thinking. The internal consistency coefficient calculated with Cronbach Alpha for the entire scale was calculated as .97.

2.1.3. Scale for determining lifelong learning tendencies

The Lifelong Learning Tendency Scale developed by Diker-Coşkun ve Demirel (2010) consists of four sub-dimensions, namely motivation, perseverance, lack of regulating learning and lack of curiosity, and a total of 27 items [41]. “Constantly learning is a passion for me.” item is an example of motivation, “Even if the subject I learned is difficult and complex, I try to learn it in the best way possible.” is an example of perseverance, “I think I will have difficulty in learning a new knowledge or skill related to my profession.” is an example of lack of regulating learning and “I prefer to spend the time I spend for my personal development with my loved ones” is an example item for the lack of curiosity sub-dimension. The scale has a 5-point Likert-type structure and is graded as "1-Does not fit at all", "2-Partly fits", "3-Does not fit very little", "4-Partly fits" and "5-Fits a lot". The internal consistency coefficient of the entire scale, calculated with Cronbach's Alpha, is .89. Accordingly, the developed scale is a valid and reliable scale [41].

2.1.4. Data analysis process

Confirmatory factor analysis was carried out based on the idea that the sample in which the measurement tools were developed in the study may differ from the sample of our study in terms of psychometrics. According to the results of the confirmatory factor analysis, the deprivation sub-dimension in regulating learning in the LLL scale was not in a significant agreement with the whole of the measurement tool, so it was excluded from the measurement tool ($p=0.768$; >0.05; S.E=0.202; C.R=0.295; β =0.023). Similarly, it is understood from the obtained results that the cooperative learning and critical thinking sub-dimension did not measure the upper dimension CT ($p=0.113$; >0.05; S.E=0.167; C.R=-1.584; β =-0.111). Therefore, it was decided to exclude these sub-dimensions from the scale. It can be said that this difference obtained with the original measurement tool is due to the study group. Considering that the group studied in this study are adults who have a bachelor's degree and aim to obtain a pedagogical formation certificate within the scope of lifelong learning; It can be said that the differences obtained in the measurement tools in which validity and reliability studies were carried out on high school and university are significant. After the CFA process, the direct and indirect effects of CT and CoT skills on LLL were examined; The results obtained are presented in detail below.

SPSS 23 and AMOS 23 programs were used in the analysis of the data obtained on a voluntary basis. In the study, the direct and indirect effects of participants' critical thinking skills and computational thinking skills on their lifelong learning skills were analyzed.

3. FINDINGS

3.1. Findings of The Descriptives Statistics and Correlation Values

Table 1. Descriptive Statistics

	n	Min	Maxi	M	Sd	Skewness	Kurtosis
MOT_LLL (1)	240	16,00	36,00	30,6042	4,38588	-,776	-,008
PER_LLL (2)	240	11,00	36,00	28,0813	5,17019	-,642	,139
LOC_LLL (3)	240	9,00	57,00	34,4396	13,16739	-,079	-1,203
COGMAT_CT (4)	240	18,00	35,00	27,9458	3,68889	-,192	-,154
ENG_CT (5)	240	25,00	55,00	43,4542	5,96626	-,110	,115
INNO_CT (6)	240	17,00	35,00	27,5667	3,82840	-,090	-,154
PROBLEM_CoT (7)	240	54,00	100,00	81,1208	9,43054	-,277	,020
CREATHINK_CoT (8)	240	21,00	45,00	34,9875	4,88913	-,379	,110
ALGOTHINK_CoT(9)	240	12,00	25,00	19,7375	2,99683	-,001	-,477
CoT (10)	240	122,00	200,00	160,0792	15,55009	,115	,100
LLL (11)	240	71,00	162,00	116,3875	23,74507	,202	1,290
CT (12)	240	66,00	125,00	98,9667	12,35387	-,012	-,122

(MOT_LLL: Motivation, PER_LLL: Perseverance, LOC_LLL: Lack of curiosity, COGMAT_CT: Cognitive maturity, ENG_CT: Engagement: INNO_CT: Innovativeness, PROBLEM_CoT: Problem solving, CREATHINK_CoT: Creative Thinking, ALGOTHINK_CoT: Algorithmic thinking, LLL: Lifelong learning, CT: Critical thinking, CoT: Computational thinking)

As seen in Table 1, participants' MOT_LLL (X=30.60), PER_LLL (X=28.08), LOC_LLL (X=34.44), COGMAT_CT (X=27.94), ENG_CT (X=43.45), INNO_CT (X=27.57), PROBLEM_CoT (X=81.12), CREATHINK_CoT (X=34.99), ALGOTHINK_CoT (X=19.74) sub-dimensions are above the average. In addition, when the total scores obtained from all of the scales are examined, it is seen that the scores are above the average (LLL (X=116.39), CT (X=98.97), CoT (X=160.08).

Table 2. Correlations

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
MOT_LLL (1)	1	,628**	,205**	,361**	,359**	,400**	,462**	,335***	,245**	,479**	,487**	,405**
PER_LLL (2)	-	1	,065	,316**	,375**	,422**	,426**	,354**	,277**	,377**	,345**	,406**
LOC_LLL (3)	-	-	1	-,049	-,061	-,012	-,051	-,040	-,074	,165*	,916**	-,047
COGMAT_CT (4)	-	-	-	1	,706**	,753**	,595**	,488**	,425**	,612**	,096	,873**
ENG_CT (5)	-	-	-	-	1	,798**	,683**	,490**	,457**	,630**	,077	,941**
INNO_CT (6)	-	-	-	-	-	1	,653**	,467**	,391**	,600**	,141*	,920**
PROBLEM_CT (7)	-	-	-	-	-	-	1	,556**	,528**	,830**	,117	,710**
CREATHINK_CoT (8)	-	-	-	-	-	-	-	1	,527**	,691**	,107	,527**
ALGOTHINK_CoT (9)	-	-	-	-	-	-	-	-	1	,597**	,044	,469**
CoT (10)	-	-	-	-	-	-	-	-	-	1	,341**	,673**
LLL (11)	-	-	-	-	-	-	-	-	-	-	1	,110
CT (12)	-	-	-	-	-	-	-	-	-	-	-	1

**<0.01; *<0.05 (MOT_LLL: Motivation, PER_LLL: Perseverance, LOC_LLL: Lack of curiosity, COGMAT_CT: Cognitive maturity, ENG_CT: Engagement: INNO_CT: Innovativeness, PROBLEM_CoT: Problem solving, CREATHINK_CoT: Creative Thinking, ALGOTHINK_CoT: Algorithmic thinking, LLL: Lifelong learning, CT: Critical thinking, CoT: Computational thinking)

The results obtained in Table 2 indicate that the MOT_LLL and PER_LLL sub-dimensions of the lifelong learning tendencies scale are cognition (p<0.01, r=0.479; p<0.01, r=0.377) and CT (p<0.01, r=0.405; p<0.01, r). =0.406) with the total score and sub-dimensions obtained in all measurement tools, COGMAT_CT (p<0.01, r=0.361; p<0.01, r=0.316), ENG_CT (p<0.01, r=0.359; p<0.01, r=0.375), INNO_CT (p<0.01, r=0.400; p<0.01, r=0.422) PROBLEM_CoT (p<0.01, r=0.462; p<0.01, r=0.426) CREATHINK_CoT (p<0.01, r=0.335) ; p<0.01, r=0.354) ALGOTHINK_CoT (p<0.01, r=0.245;

$p<0.01$, $r=0.277$) has a significant and positive relationship with sub-dimensions. On the other hand, the total score of the COGMAT_CT, ENG_CT, and INNO_CT sub-dimensions of the critical thinking skills scale in the whole of the CoT measurement tool was significant and positive, respectively ($p<0.01$, $r=0.612$; $p<0.01$, $r=0.630$; $p<0.01$, $r=0.600$). appears to have a relationship. Similarly, the PROBLEM_CoT ($p<0.01$, $r=0.595$; $p<0.01$, $r=0.683$; $p<0.01$, $r=0.653$) sub-dimensions of COGMAT_CT, ENG_CT, and INNO_CT were CREATHINK_CoT ($p<0.01$, $r=0.488$; $p<0.01$, $r=0.490$; $p<0.01$, $r=0.467$) ALGOTHINK_CoT ($p<0.01$, $r=0.425$; $p<0.01$, $r=0.457$; $p<0.01$, $r=0.391$) can be said to have a significant and positive relationship with sub-dimensions. In addition, the score obtained from the whole CT measurement tool has a positive and significant relationship with the scores obtained from the PROBLEM_CoT ($p<0.01$, $r=0.710$), CREATHINK ($p<0.01$, $r=0.527$) and ALGOTHINK_CoT ($p<0.01$, $r=0.469$) sub-dimensions. appears to have. Finally, while the LOC_LLL sub-dimension had a significant and positive relationship with the score obtained from the whole of the CoT measurement tool ($p<0.05$, $r=0.165$); It is understood that it does not have any significant relationship with the score obtained from the whole CT measurement tool ($p>0.05$, $r=-0.047$). On the other hand, there was a significant and positive correlation between the score obtained from the whole LLL measurement tool and the total score from the CoT scale ($p<0.01$, $r=0.341$) and INNO_CT ($p<0.05$, $r=0.141$); No significant relationship was found between other COGMAT_CT, ENG_CT, PROBLEM_CoT, CREATHINK_CoT and ALGOTHINK_CoT sub-dimensions. According to this, it is seen that the highest relationship is between the variables; the lowest correlation is between the variables.

3.2. Findings of the Structural Regression Model

The findings of structural regression model was confirmed with the structural regression technique of structural equation models, are presented below.

Table 2. The Achieved Fit Index Values in the Level-One CFA

Fit index values	Perfect fit	Acceptable fit	Fit Index Value Achieved in the Level-One CFA
CMIN/df	$0 \leq \chi 2/sd \leq 2$	$2 \leq \chi 2/sd \leq 3$	1.67
GFI	$0.95 \leq GFI$	$0.85 \leq GFI$	0.97
AGFI	$0.90 \leq AGFI \leq 1.00$	$0.85 \leq AGFI$	0.93
CFI	$0.95 \leq CFI \leq 1.00$	$0.90 \leq CFI \leq 0.95$	0.98
IFI	≥ 0.95	≥ 0.90	0.98
RMSEA	$0.00 \leq RMSEA \leq 0.05$	$0.06 \leq RMSEA \leq 0.08$	0.05
SRMR	$0.00 \leq SRMR \leq 0.05$	$0.06 \leq SRMR \leq 0.10$	0.05

Table 2 shows the fit indexes achieved in the structural regression model. Regarding that the model seems that the model has perfect fit indexes (CMIN/df=38.400/23) =1.67, $p=0.023$; GFI=0.98; AGFI=0.93; CFI=0.98; IFI=0.98; RMSEA=0.05; SRMR=0.05). The developed model was tested with the structural regression technique and the effects of the variables were shown in Figure 2.

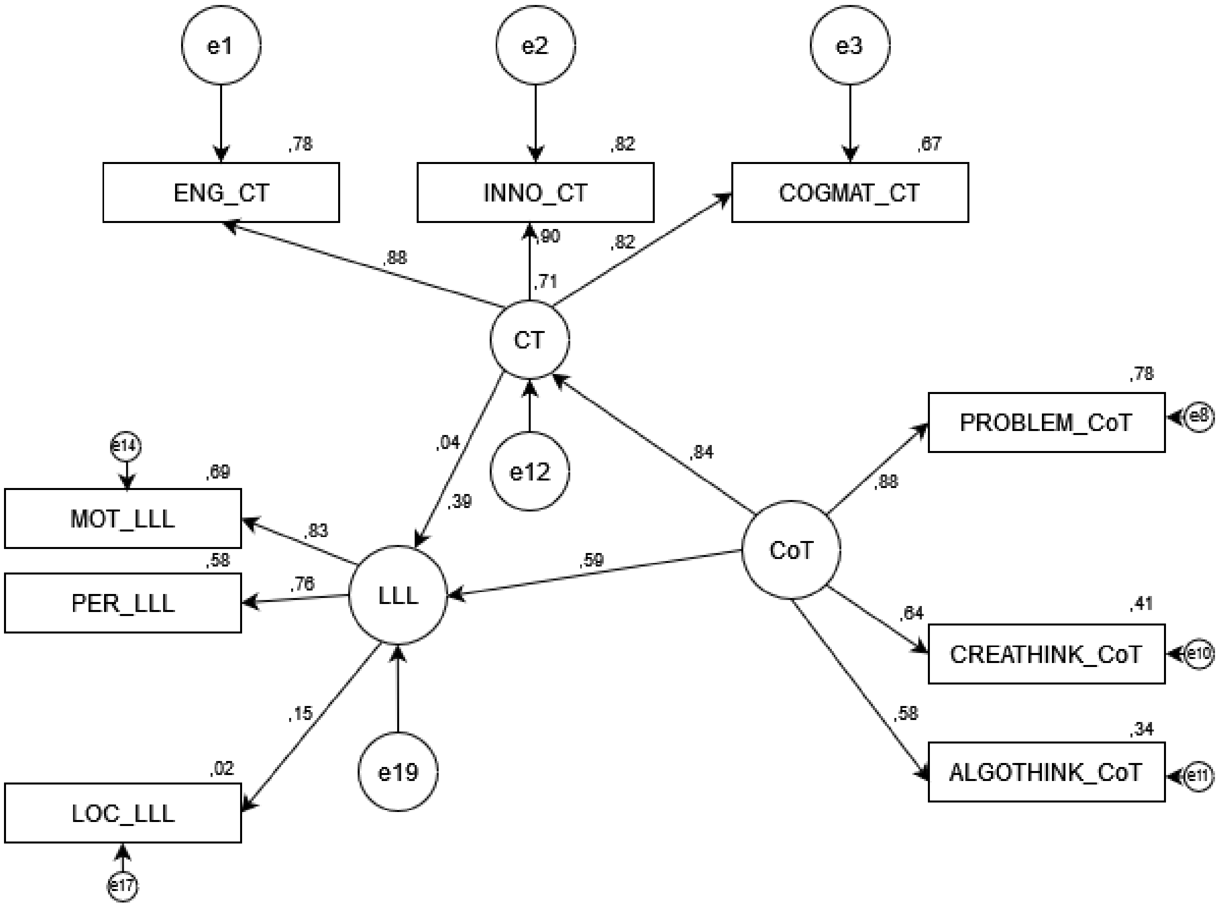


Figure 2. Testing the model with Structural Regression technique

Table 3. The Effects of variables

Dependent Variable	Independent Variable	Total Effect	Direct Effect	Indirect Effect	SE	Critical ratio (t)
CT	CoT	0.84	0.84	-	0.152	9.321***
LLL	CoT	0.622	0.591	0.031	0.218	3.153**
	CT	0.037	0.037	-	0.122	0.208
LOC_LLL	CoT	0.093	-	0.093		
	CT	0.006	-	0.006		
	LLL	0.15	0.15	-	0.263	2.062*
PER_LLL	CoT	0.474	-	0.474		
	CT	0.028	-	0.028		
	LLL	0.761	0.761	-	0.014	7.74***
MOT_LLL	CoT	0.516	-	0.516		
	CT	0.031	-	0.031		
	LLL	0.830	0.830	-	1.611	3.705***
ALGOTHINK_CoT	CoT	0.583	0.583	-	0.063	8.875***
	CT	-	-	-		
	LLL	-	-	-		

CREATHINK_CoT	CoT	0.639	0.639	-	1.468	9.586***
	CT	-	-	-		
	LLL	-	--			
PROBLEM_CoT	CoT	0.884	0.884	-	0.272	9.809***
	CT	-	-	-		
	LLL	-	-	-		
COGMAT_CT	CoT	0.687	-	0.687		
	CT	0.818	0.818	-	0.036	16.036***
	LLL	-	-	-		
INNO_CT	CoT	0.758	-	0.758		
	CT	.903	.903	-	0.035	19.005***
	LLL	-	-	-		
ENG_CT	CoT	0.742	-	0.742		
	CT	0.883	0.883	-	1.094	7.015***
	LLL	-	-	-		

*p<0.05; **p<0.01; *** p< 0.001 (MOT_LLL: Motivation, PER_LLL: Perseverance, LOC_LLL: Lack of curiosity, COGMAT_CT: Cognitive maturity, ENG_CT: Engagement: INNO_CT: Innovativeness, PROBLEM_CoT: Problem solving, CREATHINK_CoT: Creative Thinking, ALGOTHINK_CoT: Algorithmic thinking, LLL: Lifelong learning, CT: Critical thinking, CoT: Computational thinking)

When Figure 2 and Table 3 are examined together, the independent variable of CoT was directly and significantly on the CT dependent variable (β=0.84, p<0.001); On the dependent variable of LLL, both directly (β=0.591, p<0.001); appears to have an indirect effect. However, it can be said that the indirect effect of CoT on LLL is not a significant one, since the CT independent variable does not seem to be a predictor of the LLL dependent variable (β=0.037, p>0.05). When other exploratory effects are examined; The CoT independent variable has an indirect effect on the PER_CT (β=0.474), MOT_LLL (β=0.516), COGMAT_CT (β=0.687), INNO_CT (β=0.758) and ENG_CT(β=0.742) dependent variables.

In the study, it is understood that the variances of the dependent variable of LLL and CT in terms of the independent variable of CoT were 39% (r2=0.39) and 71% (r2=0.71), respectively.

In addition to this findings, the effect size was calculated on the dependent variable of LLL and CT. According to Cohen (1988) this method tests the calculated effect size whether the significant results achieved in the model and its significance in practice. To do this, it is suggested to calculate (f^2) value as follows

$$f^2 = (\frac{R^2}{(1 - R^2)})$$

for regression analyses and linear models [42].

Accordingly, by the division of multiple correlation coefficient R^2 by its subtraction from 1 $1 - R^2$; the results could be interpreted whether f^2 value is between $0,02 \leq f^2 < 0,15$ it refers to small effect, or $0,15 \leq f^2 < 0,35$ it means there is a medium effect and $0,35 \leq f^2$ it refers to have a large effect [42]. It can be therefore argued that the effects on the calculated equation for LLL is large ($f^2 = 0,64$), and for CT is very large ($f^2 = 2,44$).

4. CONCLUSION AND DISCUSSION

The aim of this study is to examine the effects of computational thinking skills and critical thinking skills of pedagogical formation students, who are considered within the scope of lifelong learning in education faculties, on lifelong learning skills. According to the results obtained within the scope of the study, CoT has a direct and significant effect on CT at the rate of 84%. Voskoglou and Buckley (2012) argue that both are necessary to solve technological problems [43]. In this case, the necessity of Computer Education and Instructional Technologies (CEIT) field in education faculties to solve technological problems emerges. In the field of CEIT, it is aimed to gain CoT skills, both pedagogically and mainly programming and coding. It is thought that the acquisition of high-level skills such as algorithmic thinking, problem solving and divergent thinking, which are CoT skills, will also positively affect CT skills. It is predicted that some courses from the field of CEIT included in pedagogical formation programs can lead to a positive change in students in order to gain these skills and contribute to developing high-level skills.

In addition, according to the results of the research, the CoT skill directly explains LLL at a rate of 59%. According to Chen et al. (2017), computational thinking forms the basis of students' participation in professional work integrating the learned problem-solving strategies in their own lives and lifelong learning [18,44]. Wing (2006) stated that computational thinking should be a part of life, should be perceived as a universal skill, and individuals should perceive, use and understand this skill in their daily lives [45]. That's why computational thinking skills are important for everyone, not just computer science. Educators need to create opportunities to learn and teach computational thinking. In order to realize these opportunities, it can be said that the teaching programs of the CEIT department, which are included in the teaching programs, are important. Technology-supported programming and coding-intensive courses given in these programs are thought to fall within the scope of 21st century thinking and learning skills. It is seen as an unthinkable fact that 21st century life skills can be realized without technology.

The direct effect of CT on LLL is not significant. The reason for this is the potential for rapid change in today's world. Societies living and questioning in today's information age need to keep up with the world in terms of critical thinking. Critical thinking has a very important place in individuals' decision making processes in terms of accuracy, usefulness and reliability of the information they have acquired [13]. It makes us think that this situation is related not only to the methods of accessing information but also to the development of digital literacy of societies. By utilizing the concepts of computer science, problem solving, system design and understanding human behavior can be developed, and LLL and CT skills can be increased by developing CoT skills.

CoT is a problem-solving process. The development of LLL and CT skills can be associated with the development of problem solving skills. Today, for the development of these skills, it is necessary to formulate problems to be able to solve them with the help of computers or other tools. After logically arranging and analyzing the data, the data can be presented through models and simulations. In addition, solutions can be automated within the framework of algorithmic thinking and resources can be used more effectively and efficiently. Mannila et al. (2014) define computational thinking as using concepts and processes in computer science to formulate problems in different fields and produce solutions [46]. As Cendon (2018) stated in his study, based on the impact of digitalization and effective use of digital technologies in higher education on lifelong learning, and just like Angeli's and Giannakos' (2020) emphasizing the importance of this situation in teacher training programs, academicians who are experts in the field of digital technologies in teacher training programs and 21st century students studying in these programs have put the same emphasis on the use of digital technologies. In this context, it is very important to include courses that support the skills of the 21st century [22,35]. In terms of using these concepts and processes in computer science, the importance of CEIT teachers at every education level emerges once again. With the education given in the field of CEIT, which develops CoT skills, students' LLL and ED skills can be improved. With this field, where algorithm and coding-based computer-aided education takes place, high-level thinking skills of students can be developed and individuals who can think critically and can learn lifelong by keeping up with the developing technology can be raised.

Constructing the applications designed by the experts in the field of education in a way that activates the computational thinking skills together with the experts in the field of CEIT. Applications can be made to enable students to develop algorithms for using their computational thinking skills. Like creating a to-do list to use time effectively. From this point of view, suggestions can be made to policy developers for the employment of CEIT.

There is a need for research on the skills at which ages, which tools, environments and methods they can be acquired more effectively and permanently [47]. As a result, CoT, which is defined as a way of solving problems, designing systems and understanding human behavior through basic computer science concepts, is thought to be among the basic skills such as reading and writing in the 21st century [45]. Therefore, it is important for learners to gain and develop BID skills in educational processes. In order to provide LLL and CT skills, individuals need to gain CoT skills. It is necessary to design and implement instructional designs and curricula in which the sub-dimensions of CoT skills are taken into account. In this way, people who can keep up with the changes and innovations in the world, continue their professional and intellectual development and strive to improve their personal skills in different fields will be able to continuously improve themselves with LLL.

CONFLICT OF INTEREST

The authors stated that there are no conflicts of interest regarding the publication of this article.

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