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Examining the Relationship between Computational Thinking, Lifelong Learning Competencies and Personality Traits Using Path Analysis

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Abstract

The purpose of this study is to determine the relationship between computational thinking, lifelong learning competencies and personality traits of university students. It was aimed to create a model that explains and predicts the relationship among the variables determined in the study. Convenience sampling method was used in determining the study group. Data were collected from 228 university students through social media. Descriptive statistics, correlation and path analysis were used to analyze the data. The results indicated that extroversion, agreeableness, and openness are statistically significant predictors of computational thinking. Among the personality traits, agreeableness yielded the greatest effect, while extroversion and openness resulted in medium effect on computational thinking. In addition, computational thinking significantly predicts lifelong learning competencies.

Keywords: Computational thinking, lifelong learning competencies, personality traits, university students

Bilgi İşlemsel Düşünme, Hayat Boyu Öğrenme Yetkinlikleri ve Kişilik Özellikleri Arasındaki İlişkinin Path Analizi Kullanılarak İncelenmesi

Öz

Bu çalışmanın amacı üniversite öğrencilerinin bilgi-işlemsel düşünme, yaşam boyu öğrenme yeterlikleri ve kişilik özellikleri arasındaki ilişkilerin tespit edilmesidir. Çalışmada belirlenen değişkenler arasındaki ilişkileri açıklayan ve yordayan bir model ortaya çıkarmak amaçlanmıştır. Çalışma grubunun belirlenmesinde uygun/elverişli örnekleme yöntemi kullanılmıştır. Betimsel tarama türündeki bu çalışmada, 228 tane üniversitede öğrenim gören öğrenciden sosyal medya üzerinden veri toplanmıştır. Verilerin analizinde betimsel istatistikler, korelasyon ve yol analizi kullanılmıştır. Araştırma sonucunda; yol analizi bulguları doğrultusunda, dışa dönüklük, yumuşak başlılık, ve deneyime açıklık, hesaplamalı düşünme üzerinde istatistiksel olarak anlamlı ve pozitif etkilidir. Kişilik boyutlarından yumuşak başlılık büyük derecede etkiye sahipken dışa dönüklük ve deneyime açıklık bilgi-işlemsel düşünme üzerinde orta etkiye sahiptir. Ayrıca, bilgi-işlemsel düşünme yaşam boyu öğrenme yetkinliklerini önemli ölçüde yordamaktadır.

Anahtar kelimeler: Bilgi-işlemsel düşünme, yaşam boyu öğrenme yeterlilikleri, kişilik özellikleri, üniversite öğrencileri

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1 | Introduction

For a qualified society in this era, individuals need to be well-trained by considering the specific needs of the society. The published development plans draw attention to the concept of developing competencies and lifelong learner in the context of current needs (Presidency Strategy and Budget Directorate, 2019). On the other hand, current conditions and needs require qualified manpower equipped with contemporary skills. Such skills that are defined as the 21st century skill set are being updated day by day with the addition of new ones, and the acquisition of these skills is vital with respect to lifelong learning competencies and problem solving ability (Alsancak-Sırakaya, 2019; Durak & Durak, 2020; Sayın & Seferoğlu, 2016). Computational thinking (CT) is defined as a must-have skill for everyone. For example, Wing (2006) defined CT as a way of computer thinking, problem solving, and system design by grasping the basic concepts of computer science. According to ISTE (2015), computational thinking is defined as a problem-solving approach that blends technology and thinking techniques and is applied to all fields. According to Gülbahar, Kert and Kalelioğlu (2019), today's students who are raised in digital era should be well-equipped individuals who have acquired 21st century skills, able to learn throughout life, and have high problem solving competencies. At this point, previous studies' findings suggest that it is important to support the relationship between lifelong learning competencies and CT skills in the continuity of these competencies. Along with the importance of this issue, it is necessary to investigate the relationship between CT skills and lifelong learning, and evaluate the findings in the context of lifelong learners, their personality traits, and competencies. However, there is no study addressing this relationship in the current literature. In addition, revealing the level of this relationship also have potential to contribute to the literature on the effects of personality traits that are hypothesized to have an effect on the research variables.

Computational Thinking

CT is defined as a thinking competence that includes understanding the basic concepts of computer science, problem-solving, system-design and human behavior (Wing, 2006). It is among the 21st century skills that future generations should develop (Zhang & Nouri, 2019). As explained by Barr, Harrison and Conery (2011), CT includes using computers and other tools to solve problems, and analyzing data, presenting data with abstraction, application of advanced solutions with algorithmic thinking, and automation. According to Shute et al. (2017), there are different operational definitions of CT based on how it is measured. The concept is still evolving as researchers continue to research on it. According to Korkmaz, Çakır, and Özden (2015), CT is an overarching concept that relates to an individual's problem solving skills through computers, creativity, algorithmic thinking, collaborative work and critical thinking skills. The conceptual framework proposed by Korkmaz et al. (2015), and Yildiz-Durak and Saritepeci (2018) was employed in this study.

Lifelong Learning Competencies

Lifelong learning has been accepted as an important socio-political and socio-economic element since the 70's (Lüftenegger et al., 2016). The reason for the increased emphasis on lifelong learning, especially as of the 90's, is the rapid transformation of the socio-economic structure. In the past, deviations in the skills and competencies that individuals should have for their social and professional lives were rather limited. However, today, competencies related to an individual's social and professional life can transform quickly. Thus, lifelong learning has become an important component for people (European Commission, 2018; Field, 2012). Evidently, it is not possible for formal instruction at schools to provide individuals all the knowledge and competencies they will need in their personal, social and professional life (Sharples, 2000). This requires individuals to obtain self-directed learning skills which include determining their own learning needs and developing a learning plan to address these needs in order to adapt to transformations in their personal, social and professional life. Self-directed learning and motivation are the two basic components of lifelong learning (Klug et. al, 2016).

Eight basic competencies of lifelong learning are listed as "*communication in mother tongue, communication in foreign languages, mathematical competence and basic competences in science and technology, digital competence, learning to learn, social and civic competences, initiative and entrepreneurship understanding, and cultural awareness and expression*" in the European Key Competences Reference Framework for Lifelong Learning (European Commission, 2018).

Personality Traits

Personality traits are relatively permanent traits that are consistent in behaviors such as thinking, feeling, and acting with respect to many different situations through life (Landers & Lounsbury, 2006; Ones et al., 2005). Among the personality frames, the five factor model stands out in determining the structure of basic personality traits (Costa & McCrae, 1992; Lin, 2010; Roccas, Sagiv, Schwartz & Knafo; Yildiz Durak & Saritepeci, 2019). This model suggests that most personality traits can be defined by the factors of openness, extraversion, neuroticism (emotional stability), compatibility, and conscientiousness. Openness is associated with being open and creative to new experiences or ideas, and having intellectual curiosity and aesthetic perception. (Costa & McCrae, 1992; Curtis, Windsor & Soubelet, 2015). Extraversion is related to the tendency of being social, active, enthusiastic, optimistic and energetic (McCare & John, 1992; Watson & Clark, 1999). Neuroticism can be expressed as an indicator of the tendency to experience negative emotional states such as depression, anxiety, concern, anger and the level of being emotionally unstable (Costa & McCare, 1992; McCare & Costa, 1997). Agreeableness is associated with the degree of being flexible, reliable, benign and humble. (Costa & McCare, 1992; Sulea etal., 2015). Conscientiousness is a personality trait associated with the degree of being determined, success-oriented, goal-oriented, reliable, planned, organized and responsible (Curtis, Windsor & Soubelet, 2015; Salem, Beaudry & Croteau, 2011).

Structural Relationship among the Research Variables

The basis of increasing emphasis on the importance of lifelong learning competencies can be explained by the differentiation of the way that tasks are completed in daily and professional life. Similarly, CT is highlighted as one of the most important skills that everyone should acquire (Wing, 2006) and involves individuals acquiring thinking patterns that they can transfer to new problems that they can encounter in the future (Chen et al., 2017). The main reason of emphasizing the necessity of building individuals' lifelong learning competencies and CT skills is to prepare them for life under rapidly changing conditions and needs. In this respect, it can be claimed that CT has an important effect on improving lifelong learning competencies of individuals. In addition, based on the literature, personality traits may mediate the relationship between lifelong learning competencies and CT skills. There are various studies supporting that a significant relationship exists between CT and personality traits (Román-González et al., 2016), and between lifelong learning and personality traits (Bath & Smith, 2020; Ekşioğlu, Tarhan & Çetin Gündüz, 2017). The purpose of this study is to determine the relationship between computational thinking, lifelong learning competencies and personality traits of university students.

2 | Method

In this study, we first created a theoretical path model as seen in Figure 1. In the model, the relationship between determined variables (computational thinking, lifelong learning competencies and personality traits) were examined. Based on the questions under inquiry, the employed research model is a descriptive survey model since it aims to reveal an existing situation without manipulating variables.

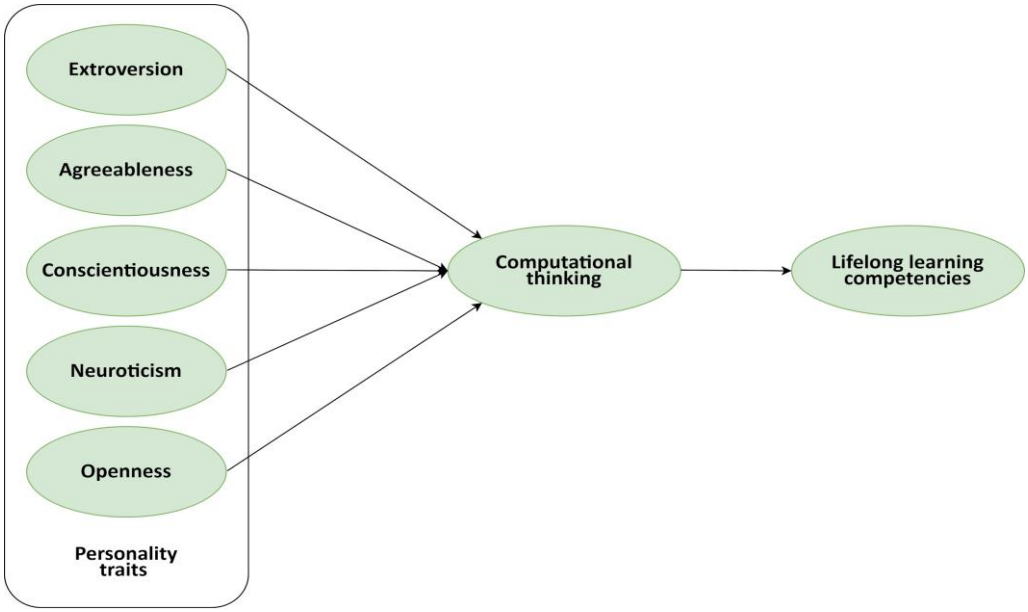

Figure 1. *Research Model*

PARTICIPANTS

The study group that consisted of 228 university students from different disciplines was chosen by using convenience sampling approach. This sampling approach enables to conduct a study with easily accessible participants. Data was collected through a digital platform from students who volunteered to participate in the 2018-2019 academic year. Personal information is presented in Table 1.

Table 1. Personal Information

Options		f	%
Gender	Female	148	64.9
	Male	80	35.1
Age	Mean=20.03; SD=2.66; Min=17; Max=34		
Branch	Computer Education and Instructional Technology	82	36.0
	Mathematics	57	25.0
	Psychological advice and guidance	33	14.5
	Turkish	56	24.6
The duration of daily use of Internet	Less than 1 hour	15	6.6
	1-2 hours	83	36.4
	3 hours and above	130	57.0
The duration of daily use of social media	Less than 1 hour	42	18.4
	1-2 hours	90	39.5
	3 hours and above	96	42.1
Online course taking experience	Yes	79	34.6
	No	149	65.4

As seen in Table 1, 64.9% of the participants are women and 35.1% are men. Participants are between the ages of 17-34 and the average age is 20.03. 57.0% of the participants stated that they use Internet for 3 hours or more per day; 42.1% of them use social media for 3 hours or more per day. The proportion of the students who have experience of taking an online course for personal development purposes in the context of lifelong learning is 34.6%.

Data collection

A personal information form and three different scales were used to collect data for addressing research questions.

Personal Information Form

This form is developed by the researchers to collect demographic information such as participants' gender, age, grade level, department, technology usage etc. (7 items).

Lifelong Learning Competencies Scale

This scale, developed by Uzunboylu and Hürsen (2011), consists of 51 items and 6 sub-dimensions. The responses are scored on a 5-point Likert scale. The Cronbach's alpha reliability coefficient for the scale was calculated as 0.965.

Computational Thinking Scale

Developed by Korkmaz, Çakır, and Özden (2016), this scale consists of 29 items and 5 sub-dimensions. The scale has a 5-point likert structure. The 5-factor structure explains 56.12% of the total variance. Cronbach's alpha reliability coefficients of the full scale and its subscales vary between 0.727-0.869.

Personality Traits Scale

It was developed by Rammstedt and John (2007) and adapted to Turkish language by Horzum, Ayas and Padır (2017). This scale has 10 items and 5 factors and aims to measure personality traits.

DATA ANALYSIS

First, descriptive statistics including means, standard deviations, skewness and kurtosis values were calculated to summarize data. Additionally, Pearson correlations among the variables were checked. Based on the literature, a theoretical path was produced and presented in Figure 1. In the model, five personality traits, extroversion, agreeableness, conscientiousness, neuroticism, and openness are exogenous variables while lifelong learning competencies is endogenous variable. CT variable is the mediator variable between endogenous and exogenous variables. In order to test the hypothesized model, path analysis was conducted using LISREL version 8.8 (Jöreskog & Sörbom, 2007). As suggested by the literature (e.g., Schumacker and Lomax, 1996; Steiger, 2007), a number of fit statistics including root mean squared error of approximation (RMSEA), comparative fit index (CFI), goodness of fit (GIF) were used to check if the hypothesized model yields a good fit. Interpretation of each fit indices along with cut values for acceptable fit are presented in the results section.

Research ethics

This research study complies with research publishing ethics. The scientific and legal responsibility for manuscripts published in Bartin University Journal of Faculty of Education belongs to the authors.

3 | FINDINGS

Descriptive statistics and relationships between variables in the study are presented in Table 2.

Table 2. Descriptive Statistics and Correlations

	1	2	3	4	5	6	7
1-Computational thinking	1	0,578**	0,226**	0,461**	0,191**	0,02	0,259**
2-Lifelong learning competencies		1	0,135*	0,446**	0,192**	0,037	0,229**
3-Personality traits (Extroversion)			1	-,265**	,187**	-0,025	,229**
4-Personality traits (Agreeableness)				1	0,045	0,076	0,064
5-Personality traits (conscientiousness)					1	0,122	,134*
6-Personality traits (Neuroticism)						1	0,111
7-Personality traits (Openness)							1
Mean	107,75	195,237	6,627	6,739	7,805	5,237	6,009
SD	16,172	27,982	1,407	1,818	1,499	1,849	1,460

When Table 2 is examined, it is seen that the CT levels (M = 107.750; SD = 16.172) reported by the participants are at the medium level. The lifelong learning competencies score of the participants is obtained as 195.237 and it is at a medium level.

As seen in Table 2, the correlation values between the CT levels of the participants and other variables are as follows; computational thinking-lifelong learning competencies awareness (r = 0.578, p <0.01), computational thinking-extroversion (r = 0.226, p <0.01), computational thinking-agreeableness (r = 0,461, p <0.01), computational thinking-conscientiousness (r = 0.191, p <0.01), computational thinking-neuroticism (r = 0.02, p> 0.05) and computational thinking-openness (r = 0.259, p <0.01).Correlation coefficients between 0.07-1.00 as absolute values are high, A relationship between 0.70-0.30 is defined as medium, and between 0.30-0.00 is defined as a low level relationship (Büyüköztürk, 2009). Based on these findings, there is a statistically significant and positively medium relationship between CT and lifelong learning competencies variables. There is a statistically significant positive low or medium level relationship between computational thinking, lifelong learning competencies variables and 4 dimensions of personality traits (except neuroticism).

PATH ANALYSIS- COMPUTATIONAL THINKING, LIFELONG LEARNING COMPETENCIES AND PERSONALITY TRAITS

The model examining the relation between personality traits, CT skills and lifelong learning competencies were tested through path analysis using LISREL 8.8 Version (Jöreskog & Sörbom, 2007). Goodness of fit indices and the standardized path coefficients are presented below.

MODEL FIT RESULTS OF THE HYPOTHESIZED MODEL

The model fit statistics of the hypothesized model were compared with the recommended values in Table 3. The fit statistics values of the hypothesized model indicated good model fit.

Table 3. Fit Statistics for the Path Model

Fit statistics	Good fit	Acceptable fit	Obtained value	Decision
*X*2	Non-significant value	-	*X*2 (4)= 2.24, p=.69	Good
*X*2/dof	≤ 3	≤ 4-5	0.56	Good
RMSEA	≤0.05	0.06-0.08	0.0 with 90%CI[0.0, .07]	Good
CFI	≥0.97	≥0.95	1.00	Good
NFI	≥0.95	0.94-0.90	0.99	Good
GFI	≥0.90	0.89-0.85	1.00	Good
SRMR	≤0.05	0.06-0.08	0.013	Good

*The recommended value are presented based on the literature (Hu and Bentler, 1999; Klein, 1998; Schumacker and Lomax, 1996; Steiger, 2007; Tabachnick and Fidell, 2001; Simsek, 2007).

Summary of Effects

As a rule of thumb, standardized path coefficients with absolute value smaller than .10 indicates small effect, values around 0.30 indicates medium effect and values greater than 0.50 indicates large effect (Kline, 1998). The standardized path coefficients and their significance are presented in Table 4 and Figure 2. According to the results, R-squared (1- unexplained variance squared) is equal to 0.63 (1- 0.37) in the first path which means personality traits explain 63% of the variance in computational thinking. Similarly, CT explains 76% of the variance in lifelong learning competencies.

Table 4. Standardized Coefficients

Direct Effect	Standardized coefficients	*t*	Rsquare
Computational Thinking			0.37
Extroversion*	0.29	5.39	
Agreeableness*	0.54	9.91	
Conscientiousness	0.10	1.95	
Neuroticism	-0.03	-0.71	
Openness*	0.15	2.95	
Lifelong learning competencies	0.89	9.22	0.66
Computational thinking*			

Based on the parameter estimates, extroversion (γ = 0.29), agreeableness (γ = 0.54), and openness (γ = 0.15) are statistically significantly positive effect on computational thinking. Among them, agreeableness has large effect while extroversion and openness have medium effect on computational thinking. In addition, CT (γ = 0.89) significantly predicts lifelong learning competencies.

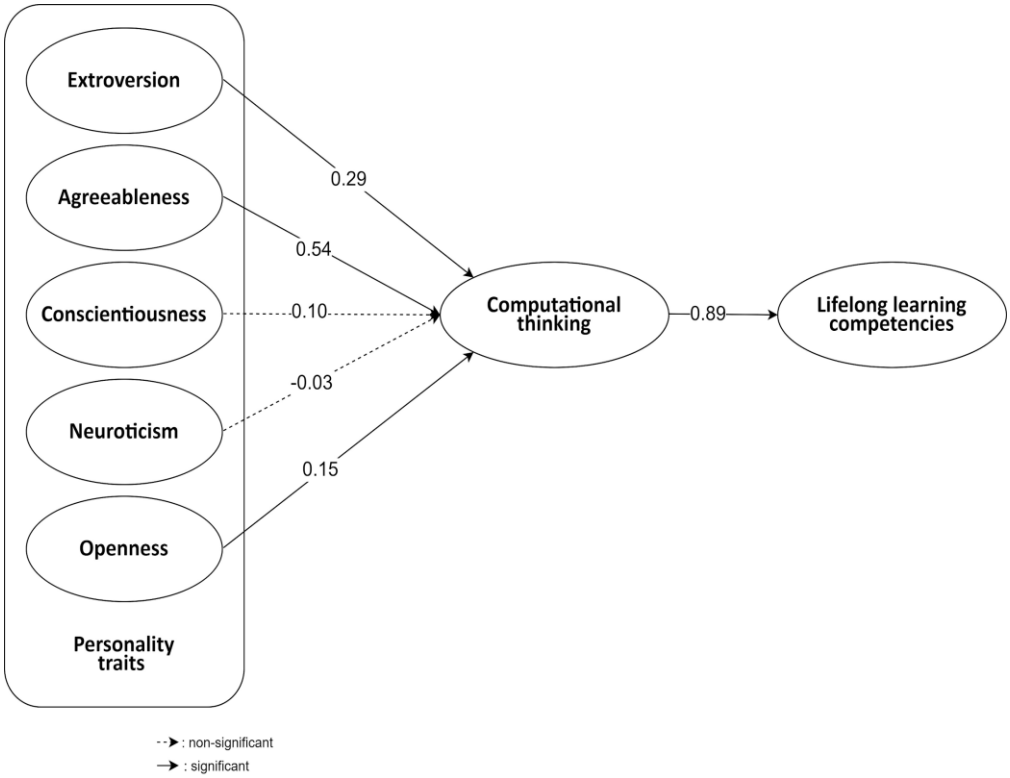

Figure 2. *Research Model Coefficients*

4 | Discussion & Conclusion

In this study, a model was created to determine the relationships between computational thinking, lifelong learning and personality traits, and the relationship between these variables was examined. According to the descriptive findings, it has determined that the CT and lifelong learning competence levels of the participants were medium. When the dual correlations were examined, a significant relationship was found between personality traits (except neuroticism) and CT and lifelong learning competencies. In addition, the most substantial relationship in correlations is between CT and lifelong learning competencies.

According to the results of the study, agreeableness has the most important relative effect on CT in the big five. This situation is compatible with the correlation between variables. CT is closely related to problem solving skills, and it can be said that "flexibility" (Costa & McCare, 1992), which is one of the basic indicators of agreeableness personality trait in particular, enables individuals to have a vast perspective on problem situations. In addition, one of the main reasons for the formation of such a strong relationship can be shown as the effectiveness of agreeableness in ensuring the continuity of participation in the course (Stajkovic et al., 2018), and it can be said that this creates that ensure individuals to make more efforts for higher performance in CT teaching activities. However, Román-González et al. (2018) concluded that there is no significant relationship between agreeableness and CT in their study. The basis of this difference between the two studies can be shown as the education level of participants in the studies. While there are participants between 5th and 10th grades in the Román-González et al. studies, this study was carried out with the participation of university students.

The relative effect of extraversion on CT is significant. Accordingly, it is understood that extraversion personality trait is an important predictor of CT. The main indicators of extroversion personality trait are associated with the tendency to be social, active, enthusiastic, optimistic and energetic (McCare & John, 1992; Watson & Clark, 1999), and they are more prone to cooperative learning. Accordingly, It can be said that it will be more enthusiastically individuals with predominant extraversion have involved collaborative

learning, which is one of the important convergent areas of computational (Yıldız-Durak & Saritepeci, 2018) such as collaborative group studies such as design-based learning (Saritepeci, 2020) and STEM (Sengupta, Dickes & Farris, 2018) in the development of CT teaching and related skills. Also, similar to the results of this study, Román-González et al. (2018) reported that there is a significant relationship between extroversion and computational thinking.

Openness personality trait is another significant predictor of computational thinking. CT is a skill closely related to problem solving and creativity (Ambrosio et al., 2014; Aho, 2012; Saritepeci, 2020). Openness represents creativity and intellectual curiosity (Costa & McCrae, 1992; Curtis, Windsor & Soubelet, 2015) as the premise of involvement and continuity of participation in problem solving processes. Scherer and Gustafsson (2015) reported that openness and creative problem solving are related. Similarly, Román-González et al. (2018) found that there is a significant relationship between CT and openness in their study.

It has been concluded that conscientiousness and neuroticism are not an important predictor of computational thinking. The conclusion that it is not significant Neuroticism, an indicator of emotional imbalance level (Costa & McCare, 1992; McCare & Costa, 1997), relationship with CT is consistent with the literature (Román-González et al., 2018). On the other hand, the result that conscientiousness is not an important predictor of CT indicates a situation contrary to the expectation. Being an important personality trait in the context of problem solving (Chartrand et al., 1993) and task performance (Reiter-Palmon & Illies, 2009) created a positive relationship expectation between conscientiousness and computational thinking. On the other hand, Reiter-Palmon and Illies (2009) emphasize that conscientiousness does not show an important role in the context of a performance task that requires creativity and creative problem solving.

According to the results of the study, it was determined that the relationship between CT and lifelong learning competencies is significant. Accordingly, it can be said that activities for teaching CT skills will improve the individual's lifelong learning competencies. The basis of this situation lies in the close relationship between lifelong learning basic competencies and computational thinking. Digital (Juškevičienė & Dagienė, 2018; Nouri et al., 2020) and STEM (Burbaitė, Drąsutė & Štuikys, 2018; Sengupta, Dickers & Farris, 2018) out of 8 key competences for lifelong learning determined by the European Commission (2018) competences has a mutual interaction with computational thinking. Regarding this situation, Juškevičienė and Dagienė (2018) state that CT is a fundamental skill that includes basic digital competencies and requires lifelong learning.

While our study provides evidence of CT and the relationships between lifelong learning competencies and personality structures, care should be taken in generalizing the findings outside the scope of the study. Student volunteering was taken as a basis in the selection of study groups. This situation can create a tendency for personality structure.

In future studies, taking into account the personality structure, the effect of CT and lifelong learning competencies can be examined by forming homogeneous or heterogeneous student groups in terms of dominant personality structure. The effects of personality structure on CT and lifelong learning competencies should be examined in detail with qualitative studies. In addition, the design characteristics that can be effective in supporting different personality traits should be defined in more detail and their effects should be examined.

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