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Footsteps of Adaptive Online Learning: Tracing the Relationships Between Online Self-Regulation, Cognitive Style, Online Interaction and Gender

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Abstract: Learners with certain personality traits adapt well to different online environments, while others may miss the necessary information for themselves or disappear entirely in the learning process. Therefore, in online learning, understanding the relationships between significant personality traits of learners and potential variables that can contribute to or hinder the learning experiences, and furthermore, the questioning of their impact on learning performance is critical to delivering effective learning experiences. The main aim of this associational study is to examine the relationships and effects of specific variables (online self-regulation, cognitive style, online interaction, and gender), on online learning and thus, to create a partial roadmap for effective online learning practices in the context of learning analytics. It also intends to understand the learners at a fine-grained level and to support individualized online learning environments. Correlation and simple linear regression analyses were used to analyze the data obtained. The findings of the study indicate that the online self-regulation scores of field-independent learners are much higher than those of field-dependent learners. In addition, there is a moderate positive correlation between the online self-regulation and cognitive style. The online self-regulation scores of the female learners are found to be higher than those of the male learners. The relationships between the variables analysed in the study are discussed in a holistic manner. It is thought that the study findings may contribute to the information on the adaptive online learning within the framework of learning analytics.

Keywords: Associational research, cognitive style in online learning, individualised learning variables in distance education, online interactions based on learner characteristics, online self-regulation skills

Highlights

What is already known about this topic:

- Online self-regulation is one of the predictors of learning achievement which depends on the autonomy of online learners
- The connections between the OSR and CS have not been analysed so much.
- There are no mutually agreed findings on the relationship between the CS and online-interaction patterns in the ODL literature

What this paper contributes:

- Cognitive style may influence learning in relation to different variables in online learning.
- The amount of online-interaction is observed to be much higher among the individuals with the skill of regulating the environmental-structure.
- It is found that OSR scores of the female learners are found to be higher than those of the male learners.
- The field-independent individuals have higher levels of persistence, and it has a very large effect size.

Implications for theory, practice and/or policy:

- The current study will contribute to future studies on the adaptive online-learning and predicting learning success based on individual learning analytics.
- Online learning platforms should analyse and take into account the connections among the individual characteristics (especially stable individual characteristics).

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Introduction

Determining the characteristics of the learner and their relationship with the learning processes is embodied with the help of the concept of learning analytics (LA). The main purpose of LA is to evaluate the various characteristics and behaviors of the learner in the learning process and to improve the learning experiences of the learners based on these characteristics (Mangaroska & Giannakos, 2018; Siemens & Long, 2011). The increasingly important data concept in education (Ifenthaler & Yau, 2020) along with LA can be implemented to better understand different aspects of education (Leitner et al., 2017). However, it is a real challenge for educators to determine which characteristics of course participants and related strategies can ensure learning success, especially in online courses (Gašević et al. 2016). In addition, there is not enough information on how the accepted potential theoretical benefits of LA can be transferred to face to face or online education (Lodge & Corrin, 2017; Viberg et al., 2018). Moreover, examples related to the effective application of LA (Herodotou et al., 2020) is quite limited. It can be claimed that this restricts the resolution of available information and linked/connected areas to understand individual differences in online courses.

By its nature, online learning is generally based on the principle that learners should control their learning for success (Bradley et al., 2017), and such a control may be shaped depending on either individual differences or online interaction behaviors. In this direction, it can be regarded as relevant to create field-specific (Yığ, 2022) or individualistic process designs that can support individual learning for online learning environments (Sezgin, 2020) and to examine the possible interrelational variables that can be effective in online learning beforehand.

As a solution to these limitations and views, this research aims to analyze and interpret the relationships between selected specific LA (considered significant in online learning by literature) to understand learners at a fine-grained level to support individualised online learning environments. The study deals with the relationships between individuals' cognitive styles (CS), online interactions (OI), online self-regulation skills (OSR) and gender. The following section explains why these variables are discussed and subjected to research in this study.

Background of the Study

Online Self-Regulation (OSR)

Self-regulation is a core aspect of adaptive human behavior that has been studied, largely in parallel, through the lenses of social and personality psychology as well as cognitive psychology. Although this characteristic is hard to change, it can be effectively developed through various teaching-learning strategies (Schunk, 2005). Self-regulated learners have a set of common characteristics such as knowing how to employ cognitive strategies, adopting learning objectives, planning time and setting well, having emotional control, having tendency to cooperation and help, developing flexible learning strategies, being active participants of the learning process, being a challenger and critical towards the others and themselves or being persistent (Wolters et al., 2005; Zimmerman, 1990). All these topics can be analysed in independent studies, but it seems obvious that self-regulation is critical for online learning (Broadbent et al., 2020) and self-regulated learners may have higher levels of academic achievement (Bannert & Reimann, 2012; Villavicencio & Bernardo, 2013). On the other hand, the statements above provide evidences suggesting that self-regulated learners are very eligible individuals for the nature of online-learning. It is reported that such individuals are eager to interact more with other stakeholders (such as other learners, teachers, educational content) (Cho & Kim, 2013), to develop arguments and to employ reflection (Cho et al., 2010) in online education settings. After all, it can be stated that online-learning demands learners to be much more autonomous in learning processes (Wang et al., 2013) because of the distributed information connections. If such an autonomy is realized through the OSR skills, it may end in long-lasting learning experiences.

Cognitive Style (CS) as an Individual Difference in Online Learning

CS is defined as a mental way that individuals employ to organize and arrange information (Messick, 1984, p.59-74). It refers to how individuals generally approach the problems they come across and how they handle the processing of information about that problem (Saracho, 1997; Sternberg & Zhang, 2005). Personality traits associated with CS do not change over time or may vary in pointless amounts (Riding & Rayner, 1998). Therefore, CS is one of the main individual differences. Identifying the CS of individuals and taking them into consideration during the learning process in the learner-centered teaching approaches may have potential implications for learning performance (Price, 2004; Riding, 2013). Although different types of cognitive styles are produced in various studies (Firth & Fitzgerald, 1985; Kaminski, 2002), of them, the most studied and popular category is developed by Witkin et. al. (1977) which contains a distinction between those with field dependent (FD) type of CS and those with field independent (FI) type of CS. There have been advances in the study of cognition since the 1980s, however, the well-established cognitive distinction between FD and FI concepts have been subject of extensive research for over 40 years and remain relevant today (Farmaki et al., 2019; Yang & Chen, 2020). Unlike other tests, group embedded figures test (GEFT) was used in this study (as described in detail in method section) to identify the CS of the participants. By GEFT, participants could create their own FD-FI profiles. Given that individual differences significantly affect learners' educational experience, the personality traits of the FD and FI individuals may also be significant predictors of the learning practices in online learning settings. Table 1 presents some major personality traits of both FD and FI individuals. However, there are limited studies on the effects of cognitive styles on online learning.

Table 1. Personality traits of the field dependent and field independent individuals (adapted from Saracho (1997))

Field-dependent (FD) individuals	Field-independent (FI) individuals
Holistic	Analytical
It takes long time for them to solve the problems of the same type.	They solve the different types of problems by structuring them
They have developed social skills and mostly adapt to social environments.	They have less developed social skills and are mostly independent from the society.
They can accept a system as it is.	They can find defects in a system.
They need more interaction with instructors or peers.	They do not need more interaction with instructors or peers.
They need external resources to identify themselves.	They depend on their internal values and standards.
They care about human relationships and want people to be around them.	They do not bother being socially isolated.
They succeed in jobs that require verbal communication skills such as teaching and marketing, etc.	They succeed in jobs that require numerical skills such as physics and math.
They can learn better studying in groups.	They can learn better studying individually.

Interaction and Gender in Online Learning

Online learning relies on the use of "asynchronistic and synchronistic" (Ku & Chang, 2011) interactional technology-oriented and technology-facilitated environments. The concepts of interaction and interactivity are increasingly important concepts in face-to-face learning as well as in online learning (Jaggars & Xu, 2016; Mehall, 2020). The reason for this is that the nature of interactivity is multi-sensory. For learners who are more isolated in online learning settings than face-to-face learning environments, interaction can be considered as a data exchange activity that addresses a known or undetected sense/attribute of the learner (from the lens of individualised learning).

Research suggests that active online interaction has positive effects on academic achievements and behaviors: specific learning outcomes for certain courses (Joksimović et al., 2015), academic

achievement (Kožuh et al., 2015), language and literacy development (Zheng, & Warschauer, 2015), motivation (Yang & Chang, 2012) and satisfaction (Arbaugh, & Benbunan-Fich, 2007). Therefore, the analysis of interactivity in relation to various learner characteristics in online learning settings may contribute to the development of efficient online learning environments which can be regulated adaptively for individual characteristics. However, it should be added that active interaction with others in online settings also requires students to have a certain degree of self-regulation (Bol & Garner, 2011; Cho et al., 2010).

In addition to interaction and self-regulation, it is thought that gender can be a sensory determinant in online learning environments (Harvey et al., 2017; Lowes et al., 2016). The effects of gender on different dependent variables in the field of open and distance learning have been referenced in many different studies (Park & Kim, 2020; Veletsianos et al., 2021; Yu, 2021. Gender, which is a discontinuous variable, can have a direct or indirect effect on many different variables with a learning context, such as OSR (Alghamdi et al., 2020), online interaction (Armentor-Cota, 2011), CS (Oh, & Lim, 2005). In this respect, it seems crucial to examine the relationship of gender variable with some other variables that may be effective in learning. Previous studies have suggested that male and female learners may have different approaches to online lessons (Lowes et al., 2016; Yukselturk & Bulut, 2009; Tsai & Tsai, 2010). However, there are still unknown spaces about gender effects in online learning in the literature (Yukselturk & Bulut, 2009). More recent studies on gender differences in online learning confirm that men and women may show different behavioral characteristics in online environments. For example, studies by Wang, Tlili, Zhong, Cai and Huang (2021) found that although men and women's online activity frequencies did not change significantly, they showed different transitional patterns in their interactions with their online learning behaviors. The moderator effect of gender in online environments was also highlighted the work of Park and Kim (2020) where they reported that "male students are more benefited from the use of interactive communication technologies in increasing the social presence, which in turn can increase the satisfaction in online learning".

The main starting point of this study is to examine the relationships and effects of specific variables (such as OSR, CS, online interaction, and gender), on online learning, and thus, to create a partial roadmap for effective online learning-teaching practices in the context of LA. Learners with certain personality traits adapt well to different online environments, while others may miss the necessary information for themselves or disappear entirely in the learning process. Therefore, in online learning, understanding the relationships between significant personality traits of learners and potential variables that can contribute to or hinder the learning experiences, and furthermore, the questioning of their impact on learning performance is critical to delivering effective learning experiences in line with the LA. Based on all these arguments given above the study attempts to answer the following research questions:

1. Do online learners' self-regulation skills and their online interactions differ significantly based on their cognitive styles?
2. Do online learners' self-regulation skills, their cognitive styles and their online interactions differ significantly based on gender?
3. Are there significant correlations between cognitive style, gender, online interaction and online self-regulations of learners?
4. Is cognitive style a significant predictor of the online self-regulated learning?

Methodology

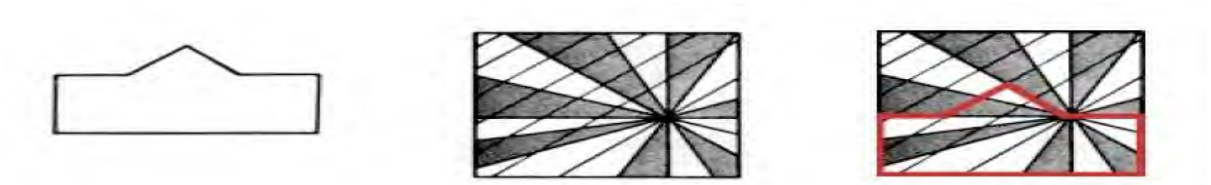
This associational research examined the relationships between different individual learning variables in online learning. Associational research is carried out to examine the relationships between 2 or more variables without manipulating the variables/any attempt to influence them, as in this research (Fraenkel & Wallen, 2006).

Participants and Measures

The participants of the study were 76 preservice teachers (third grade) attending a public university with the major of computer and information technologies. Of them, 28 were female and 48 were male. Their age ranged between 20 and 25. They had sufficient level of using computers. Preservice teachers with online learning experience were specifically selected for the sample of the study. The main reason for this was that the relationships between the variables to be examined, could be observed more easily with the help of the online learning experiences of the preservice teachers. The CS of the participants were analysed using the Group Embedded Figures Test (GEFT) (Witkin et al., 1971). Their self-regulated learning was evaluated using the Online Self-Regulation Questionnaire (SOL-Q) (Jansen et al., 2016). Also, participants' online-interactions were analysed through the descriptive data of their online-interactions.

In order to reveal the CS of the participants, GEFT, the most frequently used self-reporting tool of field-dependence/field-independence, developed by Witkin et al. (1971) was administered. The Spearman-Brown coefficient of the GEFT was reported as .82. This test depends on tracing the simple shapes in the larger complex figures. Figure 1 presents a sample item from the GEFT.

Figure 1. Sample item from group embedded figures test



The test is made up of three sections with 25 items. The first section contains 7 items for practice. The total score is the number of figures that are correctly traced in the second and the third sections. The possible obtainable maximum score is 18.

SOL-Q, which was developed by Jansen et al. (2016) and translated/adopted into Turkish language by Özdemir (2018) was employed. The SOL-Q was developed specially for online courses with a focus on individual learning activities, and thus transferable to similar settings. SOL-Q measures self-regulation with 5 factors: metacognitive skills, environmental-structure, help-seeking, time-management, and persistence. It has 36 items based on a 7-point Likert scale. The Cronbach's Alpha was .96 in Jansen et. al.'s (2016) study, however, the Cronbach's alpha coefficients of all factors in the translated version found as >.70. Accordingly, it was indicated that the validity and reliability of the translated/adapted version was acceptable.

Research Procedures

The study was conducted at a public university's faculty of education. The course, "Distance Education", was delivered for a semester in a hybrid structure to investigate and reveal the learners' behaviors in online environment. The learners used a private social network page in which they might take peer assistance and participate in online discussions. The CS scores of the participants were collected through the printed GEFT test, while the OSR levels were collected through an online questionnaire. The online interaction data of the participants were obtained from the relevant social media page at the end of the course period. The online participation data obtained in the hybrid course, which continued for a semester, were recorded separately for each participant, and the frequencies related to these participations were determined. Only the interactions of the participants were moderated, and no incentive or restriction mechanism was used. The data collection and analysis followed ethical considerations, respecting confidentiality, and ensuring that participants' participation was voluntary. Informed consent form was also gathered from participants.

Data Analysis

The GEFT was administered to all participants at the beginning of the semester. The score range in the GEFT is between 0 and 18. Witkin et. al. (1971) did not report any score range to make a distinction between FD and FI individuals. In this study, the classification of FI and FD was based on the standard deviations (SD) and means values ($\bar{x}$) of GEFT results. Accordingly, those with total GEFT score greater than ($\bar{x}$ + 1/2SD) were accepted as FI, and those lesser than ($\bar{x}$ - 1/2SD) were categorized as FD, in the present study, The SOL-Q which is used to identify the participants' self-regulated learning status was administered to the participants as an online form. The online participation of the participants was identified quantitively through the number of sentences and words they produced during the online sessions.

The data obtained were analysed using the SPSS. In order to see whether or not the data were distributed normally, the Kolmogorov-Smirnov test and skewness-kurtosis coefficients were checked. Accordingly, the data on the variables of environmental-structure and persistence (the subdimensions OSR), the online-interaction, and gender variables did not have a normal distribution. The data on other variables were found to have a normal distribution. Concerning the correlations and the significance, the following tests were employed: t-test, the Mann Whitney U test, the Spearman Rhu correlation coefficients and simple linear regression analysis. The results of the t-test and the Mann Whitney U were further analysed using the Cohen's d, Hedges' g and coefficient of determination, to identify the detailed effects of independent variables on dependent variables.

Findings

RQ1. Do Online Learners' Self-Regulation Skills and Their Online Interactions Differ Significantly Based on Their Cognitive Styles?

In regard to the RQ1, following the normality tests, it was decided that independent samples t-test would be employed for the subdimension of the metacognitive skills and for the total scores of the subdimensions of the questionnaire. For the remaining subdimensions the Mann Whitney U test was employed. Table 2 presents the results of these analyses. The effect size of the data was examined using the Cohen's d coefficient. Cohen (2013) stated that the values of d for small, medium, and large effects are .2, .5 and .8, respectively.

Table 2. Online self-regulation and online interaction in terms of cognitive style

Variable	FD		FI		*t-U* (74)	*p*	Cohen's *d*
	M	*SD*	*M*	*SD*			
Online self-regulation	4.294	.900	5.130	.772	4.332	.000	0.997
metacognition	4.700	1.093	5.325	.922	2.685	.009	0.618
time management	3.769	1.293	4.810	1.275	3.532	.001	0.810
environmental structuring*	4.969	1.650	5.735	1.021	2.447	.063	0.558
persistence*	3.651	1.277	5.146	1.263	5.127	.000	1.177
help seeking	4.379	1.541	4.632	1.602	0.701	.485	0.160
Online interaction*	13.51	17.80	18.51	17.38	1.239	.086	0.284

As indicated in Table 2, levels of OSR (t=4.332, p<.001) and its subdimensions of metacognition (t=2.685, p<.05), time-management (t=3.532, p<.05) and persistence (u=5.126, p<.001) were significantly different in terms of CS. In addition, CS did not indicate a significant difference on the participants' online-interactions (u=1.239, p<.05). The results show that the FI learners have much

higher mean scores in contrast to the FD learners for all subdimensions and variables. But it is also found that these differences are not statistically significant for the subdimensions of the OSR, namely environmental-structure and help-seeking, and for the intensity of participants' online-interaction. In other words, the FI learners generally tended to participate in online self-regulated learning process in contrast to the FD learners. However, there is no significant difference between the FI and the FD learners in terms of help-seeking behaviors and environmental-structure. In addition, although the FI learners have much higher mean score in regard to the online-interaction than the FD learners, it is not a statistically significant difference. This topic has not been analysed frequently in the open and distance learning literature. However, given that individuals with distinct CSs have differential qualities, this finding does not overlap with the previous findings since the research suggests that the FD learners much more frequently tend to participate in online-interaction than the FI learners (Sezgin, 2013). The Cohen's d values indicate that the results have medium and large effect sizes.

RQ2. Do Online Learners' Self-Regulation Skills, Their Cognitive Styles and Their Online Interactions Differ Significantly Based on Gender?

In regard to the RQ2, following the normality tests, it was decided that for the subdimension of the metacognitive skills and for the total scores of the SQL-Q, independent samples t-test could be employed. For the remaining subdimensions, the Mann Whitney U test was employed. Table 3 presents the results of these analyses. The effect size of the data was examined using the Hedges' g coefficient. The Hedges' g coefficient is similar to the Cohen's d coefficient, but it is generally used when the sample size of two groups is not similar. As can be seen in Table 3, both the total OSR score ($t=2.196$, $p<.05$) and the score the for the subdimension metacognition ($t=2.685$, $p<.05$) significantly differ based on the gender. In addition, it was found that the mean score for the online-interaction does not differ based on gender ($u=2.877$, $p<.05$). On the other hand, mean total scores for the GEFT test were found to vary based on gender. The GEFT test scores of the female participants are higher than those of the male participants. The values of Hedges' g indicate that the effect size of gender is medium for the OSR and for its subdimensions. The effect size of gender is found to be small, but near to medium level for the CS scores.

Table 3. Online self-regulation, online interaction and cognitive style scores in terms of gender

Variable	man		woman		*t*(74)	*p*	Hedges' g
	M	*SD*	*M*	*SD*			
Online self-regulation	4.525	.941	5.001	.858	2.196	.031	0.522
metacognition	4.744	1.067	5.452	.883	2.965	.004	0.705
time management	4.166	1.425	4.464	1.300	0.906	.368	0.215
environmental structuring*	5.142	1.575	5.686	1.057	1.797	.255	0.386
persistence*	4.150	1.394	4.771	1.535	1.760	.058	0.429
help seeking	4.425	1.489	4.636	1.709	0.563	.575	0.134
Online interaction*	14.71	15.42	18.07	21.09	2.877	.737	0.190
Cognitive style score	7.480	3.984	9.610	4.818	2.078	.041	0.495

Besides, the mean scores of the female participants are much higher than those of the male participants for all subdimensions and variables. These differences were found to be statistically significant for the total OSR score, the metacognition score and the CS score. Therefore, it is safe to argue that the female learners have much more tendency for the online self-regulated learning and have much higher levels of metacognition in contrast to the male learners.

RQ3. Is there a Significant Correlation Between Cognitive Style, Gender, Online Interaction and Online Self Regulations of Learners?

The results of the two-tailed Spearman Rhu (ρ) and Pearson correlation (r) analyses showed some significant positive correlations between the variables analyzed in the study. Table 4 presents the correlation coefficients of the variables examined in the study. The gender variable was produced using a dummy code.

Table 4. Correlations coefficients between cognitive style, gender, online interaction and online self-regulations of learners

	1	2	3	4	5	6	7	8	9
online self-regulation	1								
metacognition	,806**	1							
time management	,635**	,440**	1						
environmental structure	,641**	,500**	,296**	1					
persistence	,790**	,469**	,417**	,348**	1				
help seeking	,457**	,275*	-,157	,249*	,212	1			
cognitive style	,399**	,313**	,273*	,209	,421**	,088	1		
online interaction	,077	,149	,027	,280*	-,055	,074	,239*	1	
gender	,223	,337**	,083	,132	,219	,090	,210	,001	1

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

As presented in Table 4, all significant correlations are positive. Besides, there is a moderate correlation between the total OSR scores of the participants and their CS (r=.399; p<.01). CS has a moderate correlation with the subdimensions of OSR, namely persistence (ρ =.421; p<.01) and metacognition (r=.313; p<.01), weak correlation with time-management (r=.273; p<.05). There is also a weak correlation between CS and the intensity of online-interaction (ρ =.239; p<.05). Apart from these, there is a weak correlation between the intensity of online-interaction and the subdimension of the OSR, environmental-structure, (ρ =.280; p<.05). It was also found that the gender variable has a moderate correlation with the metacognition (ρ =.337; p<.01). Concerning the total OSR score and the scores of the subdimensions, the highest correlation coefficients were found for the metacognition (r=.806; p<.01) and persistence (ρ =.790; p<.01).

RQ4. Is CS a Significant Predictor of The Self-Regulated Online-Learning?

A simple linear regression analysis was performed to determine the potential of learners' CSs to predict their online-self-regulated learning. The assumptions of linear regression analysis, namely, normality of data, extreme values, linearity, mean of residuals, homoscedasticity, residuals normality were checked. The Cook distance value were also examined (.082). In addition, the analysis produced the Durbin-Watson value of 1.723 which is an acceptable/proper value (Field, 2005). Total number of the participants (n=76) was sufficient to perform the simple linear regression analysis (Stevens, 1996; Tabachnick & Fidell, 1996, p.132). The results of this analysis are given in Table 5.

Table 5. Potential of learners' cognitive styles to predict their online self-regulated learning

	B	Std. Error	Beta	t	p	R	R Square
(Constant)	4,000	,212		18,893	,000		
Cognitive style	,085	,023	,399	3,748	,000	399[a]	,160

a. Predictors: (Constant), cognitive style
b. Dependent Variable: online self-regulation

The correlation analysis and the simple linear regression analysis indicate that the CS of the participants significantly predicts their online self-regulated learning. It was found that the change in CS accounts for 16% of the participants' OSR skills. This suggests that with the increase in the cognitive style scores of the participants, the OSR skills also began to increase. In other words, the level of field independence also partially determines the degree of OSR skills of individuals. This rate can be considered to be important due to the smaller number of participants and the correlation between two variables which has not been analysed before. Therefore, it is safe to argue that CS is a significant variable for self-regulated online-learning and that this correlation can be analysed with higher number of participants.

Discussion

The first research question of the study questioned whether online learners' self-regulation skills and their online interactions differed significantly according to their cognitive style. Regarding the first research question, relevant literature indicates that the FI learners are those who are better at autonomous learning, having internal values and standards, analytical thinking and being able to see the details of a topic. On the other hand, individuals with higher levels of self-regulation are successful at the following points: specific-sequential goals, learning-centered goals, high self-efficacy, intrinsic curiosity-interest, focus on performance, self-learning, self-monitoring in the process, researching self-evaluation, strategy-using features, positive self-reactions and being compatible (Zimmerman, 1998). Therefore, it may be an expected result that such individuals succeed in organizing their online-learning and in "learning how to learn".

The connections between the OSR and CS have not been sufficiently analysed in the literature. Some studies report that the FI learners are successful in processing significant information that they choose among a bulk of information (Hodges et al., 2008). It is also reported that the use of metacognitive strategies which are the subdimension of the OSR is much more effective among the FI learners in contrast to the FD learners (Nosratinia & Adibifar, 2014). Yuwono and Wijayanti (2018) found that the male FI learners have a similar metacognitive profile like the FD learners in regard to the description of problem. However, the male FI learners were found to be much more efficient in planning the solution for that problem and in controlling it. In another study it is discovered that CS and metacognition are positively correlated (Holden & Yore, 1996). Chen (2002) concluded that CS has a significant effect in developing metacognitive strategies in online environments.

Another subdimension of the OSR that produces significant difference was found to be time-management. Time-management is a well-known self-regulated learning skill that includes scheduling, planning, and managing the personal study time (Alario-Hoyos et al., 2017). Razini et al. (2020) reports some evidences indicating that the FI individuals may be much more successful in time-management. The present study also found that the FI learners have much higher mean scores in contrast to the FD learners in the context of time-management and that this difference has a high effect size. This variable (time-management) is very consistent with the qualities of the FI learners. In other words, the FI learners may be expected to be skillful in time-management.

It was also found that the FI individuals have higher levels of persistence and that it has a very large effect size. These dimensions of the issue have not been enough analysed in relation to the connections with CS and persistence in educational settings. It is possible to expect that the FI individuals are much more persistent in online-learning settings in contrast to other individuals.

Structuring the learning environment refers to the ability of individuals to organize environmental elements that can have negative effects on their online-learning process. Positive factors that may be formed through environmental structuring include a silent environment, a fast computer and Internet access in online-learning settings. As stated earlier, the FI learners were found not to have any advantage in relation to the environmental-structure and help-seeking subdimensions of the OSR, and in relation to the amount of online-interaction.

Concerning the CSs, it is known that the FI learners are much more individualistic and have poor social skills (Sezgin, 2013; Saracho, 1997). In addition, they mostly prefer individual projects. Therefore, it might be expected that the FI learners would tend to exhibit less help-seeking behaviors in contrast to the FD learners. In the present study it was found that, although the FI learners have much higher mean scores in relation to the help-seeking behaviors in contrast to the FD learners, this difference is not statistically significant. It may be a result of the fact that the FI learners tended to rely on reflection-feedback to be successful in the learning process.

There are no mutually agreed findings on the relationship between the CS and online-interaction patterns in the ODL literature. In the study by Fite (2004) the correlation value indicated there was not a relationship between CS and quantity of online-interaction. In another study it was found that in the online discussion groups, the interaction is much more frequent among the FD learners in contrast to the FI learners (Sezgin, 2013). In the current study the amount of the online-interaction was found to be higher among the FI learners, but it is not statistically significant. On the other hand, the higher interaction among the FI learners may be a result of the structure of the online argumentation process.

In the second research question of the study, it was questioned whether online learners' self-regulation skills, cognitive styles and their online interactions differed according to gender. In connection with the second research question and results, research indicates that the male and female learners have different experiences and understandings in regard to the online-learning (Rovai & Baker, 2005; Yukselturk & Bulut, 2009). However, there is limited number of studies dealing with the relationships between online self-regulated learning and gender. In general, female learners were found to have higher levels of self-regulation, in contrast to male learners (Lee, 2002; Pajares, 2002), or both groups of learners have similar scores in self-regulated learning (Yukselturk & Bulut, 2009).

The present study found that the level of online self-regulation (OSR) is much higher among the female learners than among the male learners. One of the factors contributing to this result is the metacognition subdimension of the OSR. Similarly, some of the previous findings indicate that female learners significantly differ from the male learners in terms of metacognition (Bidjerano, 2005; Schuitema et al., 2012). In addition, Bidjerano (2005) concludes that there is no difference between the male and female learners in terms of help-seeking and that the female learners have much higher scores for the time-management and effort. In the present study gender was found to have significant effects only on the subdimension of metacognition.

Higher self-regulation scores of the female participants can be discussed from different angles. One of these perspectives argues that women's emotional and behavioral responses are more controlled in society in terms of evolutionary terms. It may be the reason for them to be much more self-regulated than men naturally (Bjorklund & Kipp, 1996). Eschenbeck et al., (2007), on the other hand, state that this difference may stem from general habits in relation to emotional regulations. Another remarkable finding in relation to the second research question is that the CS score of the female participants is significantly higher than that of the male participants. This finding contradicts with the findings that have been reported in various studies. Accordingly, a number of studies (Onyekuru, 2015; Witkin et al., 1977) found slight but persistent differences among the sexes indicating that the female participants tend to be more FD than the male participants.

The third research question interrogated whether there was a significant correlation between cognitive style, gender, online interaction and online self-regulations of learners. Counter findings were reported in the relevant literature (Hodges et al., 2008) suggesting that there is no significant correlation between CS and self-regulation. As stated earlier, intrinsically, a positive correlation between these two variables may be expected theoretically. On the other hand, this relationship should be tested with higher number of participants to provide correlational learning analytics. In addition, the FI learners are well organized and structured in their learning processes. Thus, it can be also expected that they are also good at time-management and metacognitive behaviors. Again, in parallel to the findings by Jansen et al. (2016), in

this study, it was found that metacognition is a very dominant variable in OSR. The reason for the positive correlation between the CS and the persistence subdimension of the OSR, can be that the FI individuals are competitive, independent and have self-defined goals & strategies, intrinsic reinforcement, and motivation. The research in the relevant literature do not report any finding on the tendency of individuals with distinct CSs concerning the environmental-structure. It is reported that the FD individuals are much more sensitive to the physical and social structures of their environment (Saracho, 1977).

The intensity of online-interaction has a weak positive correlation with only CS and environmental-structure. Cho & Kim (2013) argue that OSR is a mutual effort between student and teacher. In addition, given that CS has a correlation with the OSR, it can be stated that positive correlation between CS and the amount of online-interaction can be considered not to be unexpected. However, Fite (2004) reported a counter finding suggesting that there is no correlation between individuals' CS and the quantity of online-interaction. On the other hand, those with FI type cognitive-style, have poor social skills (Saracho, 1977). Therefore, it can be stated that FI individuals are not so volunteer to spontaneously interact with the participants of online environments. However, the context of the interaction should also be taken into consideration. The current study found that the FI participants had much higher levels of the interaction than those with FD type. The reason for this situation may also be that the FI individuals might have innovative ideas about novice or emerging topics or might have much more tendency to develop logical ideas in discussion groups.

In addition, the amount of online-interaction was observed to be much higher among the individuals with the skill of regulating the environmental-structure. This finding indicates that the willingness to participate in online-interaction environments may also depend on the stability of the individual's internet connection and the establishment of a comfortable communication environment. Therefore, interaction designers may determine the environmental status of online learners prior to the teaching process which can be a remarkable approach to developing an effective online-learning environment.

In the last research question, it was questioned whether CS is a meaningful predictor for The Self-Regulated Online-Learning. Self-regulation is an individual difference that may be improved through distinct strategies among the learners. In the study by Perry et al. (2004) the pre-service teachers reported that they can employ several activities which improve students' self-regulation skills. On the other hand, CS is an individual characteristic which cannot be modified. Given that the change in CS can account for 16% of the participants' OSR skills, the level of field independence can have an impact on learners online self-regulatory learning potentials through distinct strategies.

Conclusion

This study aimed at analyzing the relations among the individual differences that may have significant impact on the learning experiences in online environment. It, as mentioned above, examined the correlations between learners' cognitive styles, their online self-regulation, their online interactions and gender. The number of the studies concerning these variables is very limited. However, the theoretical frameworks of these variables suggest that these variables may be closely related. For the individualised future of online learning, it is necessary to examine as many relationships as possible regarding LA. It is also considerable to reveal the relationship of these analytics theoretically. The analyses carried out in this context indicate that the variables-differences analysed may be highly usable in online environments as LA. The adaptive use of learner characteristics in relation to the quality and efficiency of learning environments has become a standard roadmap for educators for the future of open and distance learning.

Today individuals' cognitive patterns are analysed using the different methods as in the past. Such studies are carried out to have more information and create meaning about how individuals learn and how they react to different conditions. Among them, GEFT is generally accepted that this test has a

capacity to make cognitive categories among individuals. However, in order to have much more deep information about the individuals' cognitive patterns, the other methods such as the analysis of brain waves are being employed. All these attempts provide an opportunity to have information about the nature of learning which is used to offer efficient learning settings. The findings obtained in this study provide evidence that cognitive style may influence learning in relation to different variables in online learning.

Of the variables analysed in the study, online self-regulation is one of the predictors of learning achievement which depends on the autonomy of online learners. Therefore, measuring the autonomous mobility of the individuals in online learning processes and evaluating it in relation to online education programs is a significant approach especially for online programs based on LA.

Gender is one of the basic differences among individuals. As stated earlier, learners are much more isolated in online learning process. Therefore, behavioral, cognitive and/or affective effects of gender may have critical significance for learning. Based on the study findings, it can be stated that future studies may provide further information on the nature of online learning in relation to individuals. It may contribute to the problem of "one size fits all" that studies on online learning try to provide a solution.

Interaction is also significant in developing adaptive online learning settings which are based on individual differences since it is a multidimensional pattern and may address multi senses. In other words, interactivity in online learning setting may be used as a tool to capture individuals with different qualities and to make them active participants of the learning process. It is clear that an interactive environment, which is shaped considering the different behaviors and characteristics of learners, will be an important determinant that can help online learners. However, learning designers and educators should identify the specific individual differences that are significant for the interactional environment in line with their purposes and should have a perspective to develop triggering events in the online learning process based on these individual differences. In the light of this study, the changes in the online interaction levels based on the individual characteristics may provide a significant guide for online learning settings.

In relation to online learning, it is not possible to find out a standard adaptation strategy because each different topic, each distinct group of learners, and technological devices available, may require a different strategy. However, first of all, it is necessary to analyse the individual characteristics and the effects or connections of these features on each other in that these features will guide the adaptation. The findings obtained from this study contain clues that can be used in online learning environments or adaptive learning systems that can be designed according to the cognitive style and OSR characteristics of individuals. As in the present study, future studies should analyse the connections among the individual characteristics (especially stable individual characteristics) to provide more efficient learning settings. The second necessity is to analyse the effects of such variables on learning performance. Future studies may deal with the analyses of the effects of such variables on learning performance in an experimental design.

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Sezan Sezgin: Conceptualization, Methodology, Visualization, Writing – original draft, Writing – review & editing; Data curation, Formal Analysis, Writing – review & editing.

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Ethics Statement

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000. Informed consent was obtained from all participants for being included in the study.

Conflict of Interest

The authors do not declare any conflict of interest.

Data Availability Statement

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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