



Development and Validation of the Grit Scale: Test of Measurement Invariance across University and High School Students

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ABSTRACT

The concept of grit has become a widely investigated topic in mental health and education in recent years. This study aims to develop a tool for measuring grit in high school and university students and to examine the measurement invariance of the developed scale on two different groups. A total of 586 high school students (411 female, 70%; 175 male, 30%) and 639 (437 female, 63%; 202 male, 37%) university students participated in the study. Grit Scale, Short Grit Scale, and Beck Hopelessness Scale were used as data collection tools in the study. The exploratory factor analysis results indicated that 14-item Grit Scale with three sub-dimensions explained 61.88% of the variance. The dimensions in the scale were named Perseverance, Commitment to Goals, and Consistency of Interest. Confirmatory factor analysis showed that the three-dimensional structure of the Grit Scale fit the data well, with measurement invariance between the high school and university student groups. Cronbach's alpha internal consistency coefficients of the total score and sub-dimensions of the scale were found as .87, .85, .84, and .75, respectively. Convergent validity was evaluated by calculating the zero-order correlation between the Grit Scale and Short Grit Scale and a significantly high positive correlation was found ($r = .655, p < .001$). Divergent validity was evaluated by examining the relationship between Grit Scale and the Beck Hopelessness Scale and a mild correlation was found ($r = -.484, p < .001$). The study revealed that the Grit Scale is a valid and reliable measurement tool that can be used with adolescents and university students.

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Keywords:

Grit, perseverance scale development, measurement invariance.

1. Introduction

Psychology has always sought answers to the question of what makes people different from one another, what factors cause one person to be more successful than another who grows up in the same family, whether the differences between people are caused by genetic factors or by environmental factors in which individuals grow up. These questions have always had an important place in the field of education as well. When considering the features that predict success in educational processes, the effectiveness of effort and talent in these processes has always attracted the attention of researchers. This question has also been related to the issue of how much individuals can benefit from educational processes. Within this scope, these questions had an important effect on developing the first intelligence tests. In the history of psychology, many theories and

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views have been put forward within the nature vs. nurture discussions, longitudinal studies have been conducted on identical twins, and many studies revealed scientific findings on the issue. However, over time, it has been observed that the emphasis on the effects of genetic factors has shifted to dimensions such as environmental factors, the richness of life experiences, and educational opportunities. One of the concepts that are widely emphasized on this subject is grit. American psychologist Angela Duckworth has sought answers to questions such as *"Is effort or talent the most important determinant of the success of individuals? Why some people are more resilient in difficult educational processes, while others give up in a short time?"* in her studies throughout the years and she came up with a theory regarding the concept of grit (Duckworth et al., 2007).

Turkish Language Association (TDK, 2021) defines grit (*azim*) as *"the determination to overcome the obstacles"*. However, (Duckworth, 2016) added a new dimension to the concept after investigating the issue throughout the years by stating that the concept of grit should not be addressed only with the dimension of being determined and persistent in dealing with obstacles and difficulties. She defined grit as the determination of the individual in his efforts and the consistency of his interests. Thus, the concept of grit refers to perseverance and passion for long-term goals (Duckworth et al., 2007). In this context, grit is about being resilient in the face of adversities and difficulties of life, and at the same time, it is about having objectives and life goals that the individual will adhere to in the long term (Perkins-Gough, 2013). Hence, grit is the individual's commitment to long-term goals with persistence and passion. This passion expresses consistency over time rather than intense emotions (Duckworth et al., 2007). When the individual begins to enjoy his work, passion starts to emerge. According to this view, grit means pursuing high-level goals consistently for a long time. However, the individual's lack of well-structured goals may result in a lack of grit. Therefore, the individual needs to have a well-structured hierarchy of goals, and these goals must be interrelated and integrated (Duckworth, 2016). Analyzing grit within the framework of character strengths, Peterson and Seligman (2004), discussed the concept of grit as a feature of courage, which is one of the features of character strengths, and defined grit as the determination to continue one's efforts voluntarily despite the obstacles, difficulties, and discouraging situations. Individuals who have grit as a positive personality trait have high expectations and complete hard work despite the obstacles and the urge to give up (Carr, 2013). The individual's desire to pursue their passions and dreams, believing in themselves, doing their best, working hard, thinking about the future, and giving up old habits are also characteristics evaluated within the framework of grit (Wedding, 2014).

Grit means being resilient in the face of failure or negative experiences (Perkins-Gough, 2013). Grit is closely related to the concept of success, and grit in this process often predicts success more than talent because being talented in a certain subject causes an individual to make an effort only up to a certain point. In this process, grit often predicts success more than talent because being talented in a certain subject causes an individual to make an effort only up to a certain point and then stop working upon reaching that threshold. On the contrary, gritty people do not stop working at a certain threshold because they have a permanent habit of working, and they keep working hard even after they achieve. They keep working hard even after achieving considerable success. On the other hand, the road to success is often long and every individual faces many obstacles and difficulties in this process, and from time to time they experiences some failures. Thus, individuals who achieve success in the long term are, above all, gritty individuals.

For this reason, those who stop trying and working when faced with obstacles or who constantly change their interests have a lower chance of succeeding (Credé et al., 2017). Similarly, Duckworth (2016) argued that putting effort is twice as important as talent, and she talked about two significant characteristics of people who achieve superior success: they have extraordinary endurance and diligence, and they are well aware of what they want, and they act accordingly. She also defined these characteristics as the basic components of grit. According to this approach, focusing too much on talent involves some potential harm. In labeling and categorizing individuals according to their talents, there is a risk of overshadowing and discarding various traits of individuals, most importantly grit. Studies have shown that grit predicts success beyond and above talent (Duckworth & Quinn, 2009).

Various views have been put forward on the development of grit, and related questions have been asked about the concept, just like the discussions on personality. These questions were related to whether grit comes from birth, whether it is a personality trait, and whether it changes according to environmental conditions. Findings of studies show that grit is a trait that changes depending on environmental interventions, such as the individual's efforts and the amount of time spent on the task at hand (Alan et al., 2019; Cross, 2014). Grit, like

all other personality traits, is affected by genetic factors. The Grit Scale was administered to 2000 twins in a study conducted in England. According to the results, the genetic transmission rate of the determination subscale of grit was calculated as 37%, and the genetic transmission rate of the passion scale was calculated as 20%. This situation revealed that the remaining part was explained by experience and showed that grit is a feature that could be developed (Duckworth, 2016). Peterson and Seligman (2004) dealt with the concept of grit within the framework of character strengths and indicated that grit is a trait that can be learned.

Techniques such as rewarding individuals' efforts, teaching them to attribute their failures to insufficient efforts and giving them positive feedback in cases of learned helplessness contribute to the development of grit. Duckworth (2016) put forward four dimensions of the development of grit. The first is increasing interest and passion and enjoying what we do. The second one is to practice. Doing something better than the previous day, making it a part of one's nature by repeating it continuously, and demonstrating a long-term steady effort and determination for all these. The third is to have goals that mature the passion, make the individual move forward and sustain. To achieve this, it is significant that the individual sets the goals that serve the well-being of both himself and others. The fourth one is hope. According to this dimension, hope is a force necessary for every stage of grit that keeps the individual's perseverance alive, uplifts them when they falls, and makes them move forward when they make a false step. Similarly, Tough (2012) stated that grit can be developed by education. Grit is a trait that can be developed by education by functional reinterpretation of various life experiences, and it significantly predicts the success levels of individuals. Diener et al. (2009) indicated that the ability of the individual to adapt to the situation when faced with obstacles and difficulties also plays an important role in building grit. Re-evaluating negative events with a positive perspective helps the individual to show grit and become perseverant in achieving their goals.

It has been determined that the concept of grit has important consequences for individuals in various fields such as mental health and education. With the studies conducted by Duckworth (2016) and Peterson and Seligman (2004), the concept of grit has started to be considered one of the protective and developing factors in mental health. Several studies have shown that the concept of grit has a significant positive relationship with variables such as resilience (Jin & Kim, 2017), academic performance (Pate et al., 2017), life satisfaction, happiness, well-being, and positive emotions (Jin & Kim, 2017; Peterson et al., 2007; Singh, 2008). Studies also revealed that grit reduces the risk of suicidal ideation by developing meaning in life (Kleiman et al., 2013). The concept of grit has been considered as one of the variables closely related to academic success, it has been examined as one of the strong variables that predict success (Eskreis-Winkler et al., 2014; Tang et al., 2019), and the concept of academic grit has been introduced in concerning this. The concept of academic grit is related to setting goals regarding the educational processes of individuals, overcoming the difficulties they encounter in the process of achieving these goals, and their determination and endurance in this process (Sağkal, 2020).

Since the period during which first intelligence tests were developed in the field of education and psychology, cognitive variables such as intelligence have been predominantly used in predicting success, and non-cognitive dimensions such as grit have been addressed in a more limited way. In this context, the relationship between the concept of grit as a non-cognitive variable success and performance has begun to be investigated extensively (Kannangara et al., 2018) with the introduction of virtues and character strengths that were discussed within the positive psychology approach and Duckworth et al.'s (2007) extensive research on the concept. The US Department of Education published a report in 2013, stating that skills such as grit, tenacity, and perseverance are important components of learning processes and success in the 21st century. These non-cognitive skills are critical for individuals to achieve long-term and high-level goals and cope with the difficulties they face in school life and other areas of life. Within this scope, it has been suggested to all stakeholders of the educational field to create educational environments that allow the development of these traits of individuals (Shechtman, 2013). Thus, it can be said that the concept of grit is critically significant for the field of education. This situation, on the one hand, points out the importance of investigations on the subject and intervention studies aimed at developing grit, and it reveals that new tools need to be developed to measure the concept of grit.

When the literature is examined, no other measurement tool for measuring grit has been found other than the Grit Scale developed by (Duckworth & Quinn, 2009). Within this scope, the Grit Scale was used in most of the studies on the concept of grit that were conducted in different cultures. Although adaptation studies have been undertaken for this scale, the scale is a measurement tool developed in the individualist western culture.

In this context, it was noticed that a significant part of the research on grit was conducted in American culture (Tang et al., 2019). Traits such as grit are variables that are closely related to culture (Datu et al., 2016). On the one hand, this situation shows that the cultural adaptation studies of the existing measurement tools should be done carefully, on the other hand, it also points out the importance of developing cultural-sensitive measurement tools. Related studies in the literature reveal that while using a single measurement tool is beneficial in terms of comparison, this might put the studies, which investigate an important concept like grit, in a vicious circle after some time.

On the other hand, recently, various opinions have been put forward regarding the predictive power, sub-dimensions, and insufficiency of the measurement power of the Grit Scale (Datu et al., 2016; Tang, Wang, et al., 2021). One of the current debates about grit is the suggestion that studies on grit in adolescents are limited, most studies are conducted with university students, and that these groups should be diversified (Tang et al., 2019). In addition, various studies have shown that the dimension of commitment to goals has been neglected, or that the dimension of consistency of interest yielded different results in collectivist cultures, and suggestions have been made that different dimensions should be considered in measuring grit (Tang, Wang, et al., 2021). Based on these discussions, it is thought that the development of new measurement tools in different cultures and age groups will allow the emergence of different dimensions and orientations regarding the concept and in this way, this will contribute to the development of the literature on the topic with different perspectives. Although the Short Grit Scale was adapted to the Turkish language, it is thought that developing a new measurement tool for Turkish culture in the context of new and different discussions and suggestions would fill an important gap in the literature. It is seen that, in Turkey, the tools for measuring traits such as grit, tenacity, and perseverance are limited, and the existing measurement tools are the ones that have been developed and adapted in other cultures. Although the validity and reliability of the measurement tool are calculated by statistical methods in adaptation studies, it is thought that it is important to develop the measurement tool directly in the respective culture, rather than adaptation, especially in the measurement of some culture-sensitive personal traits. This situation will partially reduce the already existing limitation of self-report measurement tools and will reveal the desired feature to be measured in a more reliably.

2. Methodology

2.1. Research Model

The research is a scale development study carried out with the general survey model. The scale development process was carried out within the framework of the steps that Worthington and Whittaker (2006) suggested as a result of their study based on an extensive literature review.

2.2. Research Sample

Using the convenience sampling method, 586 (411 female, 70%; 175 male, 30%) high school students and 639 (437 female, 63%; 202 male, 32%) university students were recruited via classroom announcement in the present study. The range of age is from 14 to 19 ($M= 16.01$, $SD= 1.27$) for high school students and 18 to 32 ($M= 21.37$, $SD= 2.37$) for university students. The procedures and aims of the study were explained to each volunteer student before taking their written consent. Furthermore, the purposes and procedures of the study were approved the local ethical committee of the university.

2.3. Data Collection Tools and Procedure

Short Grit Scale (Grit-S): The Grit-S is a 8-item self-report measure to evaluate trait level perseverance and passion for long-term goals (Duckworth & Quinn, 2009). The Grit-S has two components: Consistency of Interest and Perseverance of Effort and a total score. Four items of Grit-S were reverse coded, and the higher scores represent higher grittiness. The Turkish form of Grit-S has the original factor structure (Sarıçam et al., 2016). Both subscales and total scores of Grit Scale have reasonable reliability in the present study; Cronbach's alphas for consistency of interest, perseverance of effort, and total score were .63, .74, and .68, respectively.

Beck Hopelessness Scale (BHS): BHS, developed by Beck et al. (1974), is a 20-item true-false self-report measure that evaluates the individual's negative expectations for the future. Eleven of the items are keyed true and 9 false. The items are summed to obtain a total hopelessness score, ranging from 0-20. The higher scores demonstrate the higher level of hopelessness. The validity and reliability studies of BHS were conducted by

Seber et al. (1993) and Durak and Palabıyıkoglu (1994). In the current study, Cronbach's alpha reliability coefficient of BHS was .86

Item Development Process: For the item development process, we carried out a comprehensive literature review on the topic of grit at the first stage. In this context, the studies and theoretical approaches put forward within the framework of the concepts of grit (Duckworth, 2016) and perseverance (Peterson & Seligman, 2004) were examined. As a result of this examination, we started to form an item pool for measuring this concept. Then, after taking the opinions of the field experts and conducting a pilot study with a total of 258 students, 112 of whom were high school students and 146 university students, we created a 27-item question pool. First, an exploratory factor analysis was conducted on this pool of items. As a result of EFA analysis, the final scale form consisting of 14 items was obtained. The model was tested with the confirmatory factor analysis (CFA) and this analysis was performed on two different groups of both high school and university students. As a result, it was revealed that the scale's goodness of fit index values were good and the scale's factor structure was confirmed.

2.4. Data Analysis

SPSS 21 (IBM Corporation, 2015) and Mplus 7.3 (Muthén & Muthén, 1998-2012) were used for the statistical analysis. Following the calculation of the socio-demographic characteristics of the sample, several additional statistical analysis were conducted; i) calculating skewness and kurtosis values, ii) corrected-item total correlation, iii) assessment of the construct validity of the Grit Scale by using explanatory factor analysis and confirmatory factor analysis (CFA), iv) convergent and divergent validity performing the Pearson moment product correlation analysis the Grit Scale and relevant measures, and calculating average variance extracted and composite reliability, v) testing the reliability calculating the Cronbach's alpha and retest reliability with a time interval of two weeks, vi) examining measurement invariance performing several multi-group confirmatory factor analysis.

Skewness and kurtosis values were less than ± 1.2 , which fell between Tabachnick and Fidell's (2007) recommendation. The corrected-item total correlation coefficients of all the 27 items were greater than .30 (Nunnally & Bernstein, 1994). We randomly split the sample into two groups. In the first group ($n=628$), due to the principal component analysis (PCA) is a technique for reducing the dimensionality of the data (Tabachnick & Fidell, 2007) and it is a psychometrically sound and less complex procedure, we performed a PCA on the 27 items to investigate the dimensional structure of the Grit Scale (Field, 2009). Considering that factors were expected to correlate each other, an oblique (Promax) rotation was performed (Tabachnick & Fidell, 2007). Moreover, parallel analysis were run to determine the number of factors, using Horn's (1965) procedure. Then, confirmatory factor analysis was performed using maximum likelihood estimation on the second group ($n= 597$). We used the following commonly used fit indices (Brown, 2015; Kline, 2011) and acceptable ranges to evaluate model fit (Hu & Bentler, 1999; Tabachnick & Fidell, 2007): the CFI ($\geq .90$), the TLI ($\geq .90$) and the RMSEA ($\leq .08$) with a 90% CI. In addition, the composite reliability (CR), average variance extracted (AVE) and Cronbach's alpha were calculate to evaluate the validity and reliability of the Grit Scale.

To examine measurement invariance across the high school students and university students group, we performed several multi-group CFA to examine the Grit Scale's configural, metric and scalar invariance (Li et al., 2015; Vandenberg, 2002). First, as baseline models, the models were estimated freely for both high school and university students. Then, the configural invariance evaluated whether the Grit Scale was best described with three-latent factors for the two groups. Factor loadings were constrained to be equal across groups in the metric invariance. To examine scalar invariance, intercepts and factor loadings were set to be equal. To compare the increasingly nested models, chi-square difference test ($p > .05$) and recommended change in fit indices were used: $\Delta CFI \leq .010$; $\Delta TLI \leq .010$; $\Delta RMSEA \leq .015$ (Chen, 2007; Cheung & Rensvold, 2002).

2.5. Ethical

The authors declare no conflict of interest. The participants were informed about the study, and the approvals for participation in the study were received. The compliance of the research process with ethical rules was ensured with the approval of the ethics committee obtained from the Erzincan Binali Yıldırım University ethics committee with the number E-85748827-050.06.04-65991.

3. Findings

3.1. Exploratory Factor Analysis (EFA)

The sample was randomly split into two groups. In the former subgroup ($n= 628$; 298 high school students, 330 university students), the PCA with an oblique rotation (Promax) was conducted on the 27 items to investigate the dimensional structure of the Grit Scale. The present study had the 23:1 subject to item ratio above Costello and Osborne's (2005) recommendation. Moreover, the Kaiser-Meyer-Olkin (KMO) measure was .94 (in the superb range), which verified the sampling adequacy. All KMO values for individual items (diagonals of the anti-image correlation matrix) fell between .71 and .97, which is well above the acceptable limit of .5 (Field, 2009). To determine the presence of multicollinearity, the correlation was investigated (i.e. $r < .89$; Field, 2009) but all correlations were below than .61. Bartlett's test of sphericity, $\chi^2(351) = 7365.008$, $p < .001$ revealed that there is an adequately large correlation between items for PCA.

An initial factor analysis was performed to calculate eigenvalues for each component. Five components had eigenvalues greater than Kaiser's criterion of: 9.88, 1.77, 1.58, 1.054 and 1.018, respectively. This solution explained 56.67% of the variance. Horn's (1965) parallel analysis was performed using the SPSS syntax provided by O'Connor (2000) to determine the number of factors. Parallel analysis compares the extracting eigenvalues from the actual sample correlation matrix with the eigenvalues extracting from a random correlation matrix. Factors are retained if the actual eigenvalue is larger than the eigenvalue from the random data. The result of the parallel analysis indicated that the eigenvalues of first five factors are; 1.46, 1.38, 1.33, 1.29 and 1.25, respectively. According to the parallel analysis, three factors were retained because the eigenvalue of the fourth factor of the random data are higher than that of the actual data. Investigation of the scree plot clearly showed inflexion that would justify retaining of three components. Given the large sample size, eigenvalues and scree plot, a second factor analysis (PCA; Promax rotation) was conducted with a fixed number of three factors. Three-factor solution explained 49% of variance. The pattern matrix and structure matrix were investigated to define which items to retain (Tabachnick & Fidell, 2007). Because the greater factor loading are considered indicative of well-defined structure, an item was retained and loaded to a factor if its loading was .60 or greater for that factor (Comrey & Lee, 1992). Ten hyperplane items that had not loaded on any of the factors and three items that had loaded on two factors were removed, and the EFA was rerun. The final three-factor solution had 14 items that explained 61.88% of the variance.

The first factor, called Perseverance (Pers), includes five items for coping with difficulties and not giving up; it explains 40.38% of the variance. The second factor comprises five items focusing on the pursuing goals and explains 11.92% of the variance. This factor was named as Commitment to Goals (CtG). The last factor, called Consistency of Interest (CI) includes 4 reverse-coding items focusing on the consistency of interest and goals and explains 9.59% of the variance. Considering the oblique rotation, there were moderate or strong correlations between factors: Factor 1 and 2 ($r = .56$), Factor 1 and 3 ($r = .39$), Factor 2 and 3 ($r = .33$). Table 1 indicates the factor loadings of all 14 items.

Table 1. Factor structure and loadings of the Grit Scale

Item	R_{ij}	Factor 1 (Pers)	Factor 2 (CtG)	Factor 3 (CI)
I5	.651	.795		
I9	.430	.760		
I10	.563	.827		
I11	.646	.804		
I13	.584	.718		
I1	.593		.809	
I2	.582		.759	
I4	.548		.767	
I6	.651		.823	
I7	.550		.748	
I3	.545			.653
I8	.485			.809
I12	.413			.746
I14	.419			.805

Note: R_{ij} : Corrected item total correlations, Pers= Perseverance, CtG= Commitment to Goals, CI= Consistency of Interest

3.2. Internal Consistency

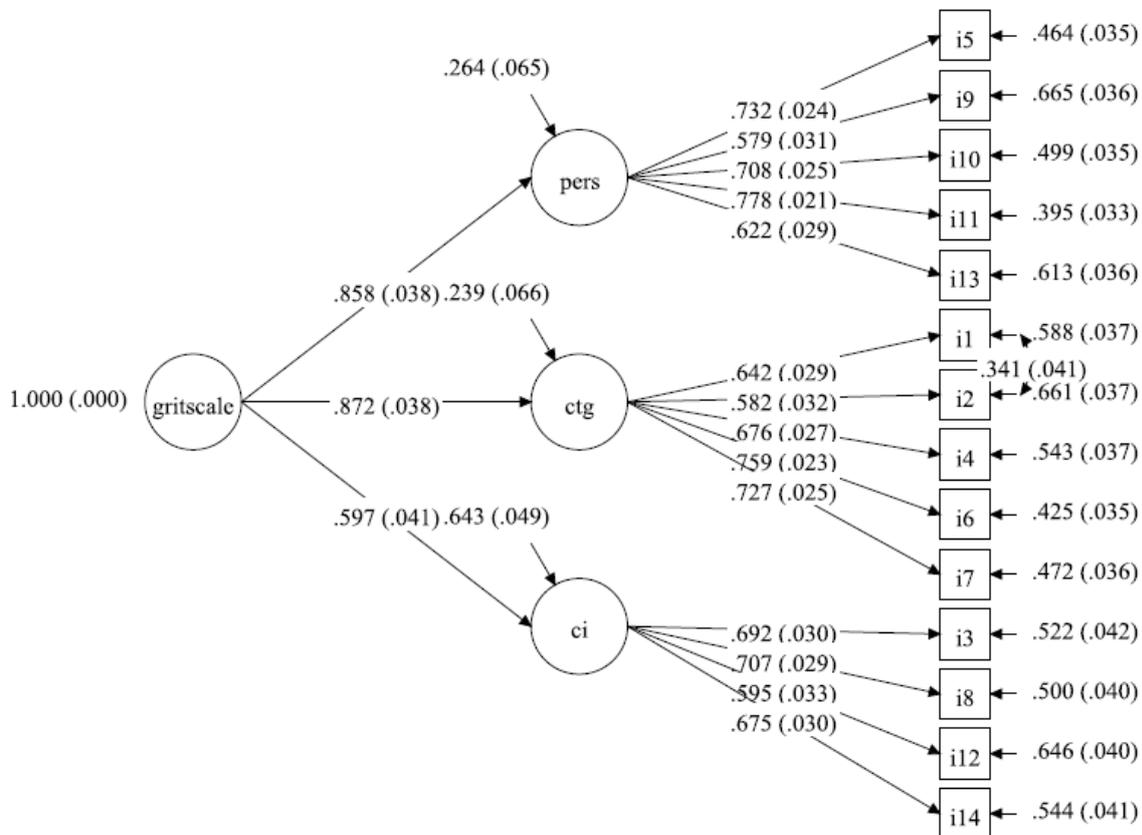
Internal consistency was tested using Cronbach’s alpha. The total Grit Scale ($\alpha=.87$) demonstrated high internal consistency. The corrected item-total correlations range from .49 to .65 and none of the items would increase the internal consistency if they were deleted. The Grit Scale subscales also had acceptable internal consistency, which are .85, .84 and .75, respectively. The all corrected item-total correlations for all subscales were above .48. Moreover, none of the items would increase the reliability of the relevant sub-factor, if it were removed.

3.3. Retest Reliability

A total of 72 participants completed the Grit Scale a second time, about two weeks after they responding the first Grit Scale administration. Retest reliability was tested by calculating zero-order correlations between the first and second administration scores. The total Grit Scale demonstrated adequate retest reliability ($r= .736$, $p< .001$). Moreover the Pers, CtG and CI also indicated well retest reliability; correlation coefficients were .858, .848 and .892, respectively (all p 's $< .001$).

3.4. Confirmatory Factor Analysis (CFA)

To examine the three-dimensional latent structure of the Grit Scale, a second-order CFA was performed in the second group consisting of 288 high school students and 309 university students. The CFA results demonstrated that the three-factor model of the Grit Scale adequately fit the data. Goodness-of-fit indices for the CFA model were as follows: $\chi^2=253.060$, $df= 74$, $CFI= .94$, $TLI= .93$, $RMSEA= .064$ [90% CI .055 to .072], $SRMR= .046$. Modification Indices demonstrated a possible covariance between the error variances related to the indicator variables of I1 and I2. Since the two items are semantically close and located in the same sub-factor, covariance between the error variance of the two items was put and the CFA was run again. The last CFA results showed that the model had better fit ($\chi^2=196.917$, $df= 73$, $CFI= .96$, $TLI= .95$, $RMSEA= .053$ [90% CI .044 to .062]). All items of the Grit Scale loaded strongly (.58 to .87) onto the respective latent factors. Moreover, the three dimensions loaded strongly on the general factor (ranging from .60 to .87; see Figure 1).



Note. CtG= Commitment to Goal, Pers= Perseverance, CI= Consistency of Interest. All loadings are significant at $p < .001$

Figure 1. The Factor Structure of the Grit Scale.

3.5. Convergent and Divergent Validity

Convergent validity was evaluated by calculating the zero-order correlation between the Grit Scale and Short Grit Scale. The Grit Scale had a significant high positive correlation with the Short Grit Scale ($r = .655, p < .001$). The Pers, CtG, and CI, the subscales of the Grit Scale, also had a positive correlation with the Short Grit Scale; the correlation coefficients were .552, .485 and .569, respectively (all p 's $< .001$). Additionally, the composite reliability of all three subscales ranges from .76 to .82, which fulfills the recommended level of .60 (Fornell & Larcker, 1981). The average variance extracted ranges between .45 to .47 and is a little below the recommended level of .5. According to Fornell and Larcker (1981), the average variance extracted is a more conservative measure, and "on the basis of the composite reliability alone, the researcher may conclude that the convergent validity of the construct is adequate, even though more than 50% of the variance is due to error" (p. 46). As the composite reliability of the three subscales is well above the acceptable level of .6, we may conclude that the convergent validity of the Grit Scale is adequate. Table 2 summarizes the composite reliability, average variance extracted and Cronbach's alpha of the subscales of the Grit Scale.

Table 2. Composite Reliability, Average Variance Extracted and Cronbach's Alpha Values

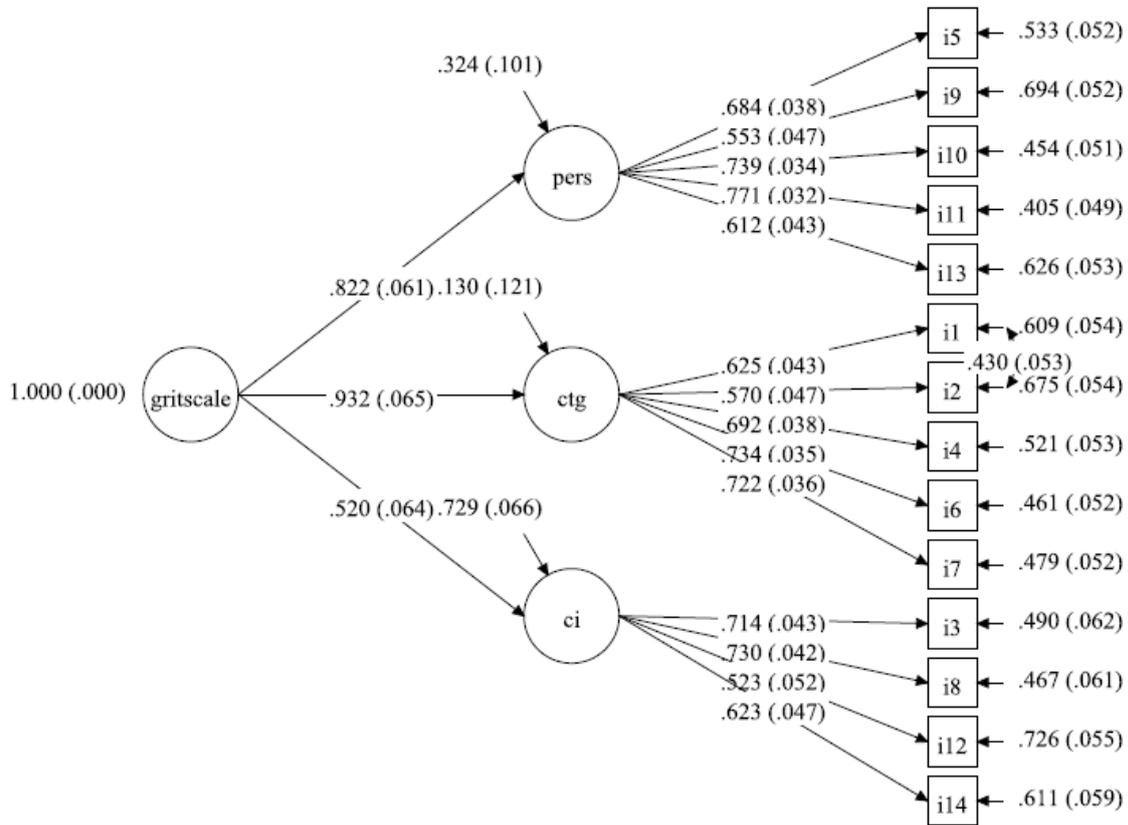
Subscale	CR	AVE	Cronbach's alpha
Perseverance	.82	.47	.85
Commitment to Goals	.81	.46	.84
Consistency of Interest	.76	.45	.75

CR= Composite reliability, AVE= Average variance extracted

Since hopelessness and perseverance are expected to have the opposite nature, the association between the Grit Scale and the Hopelessness Scale was examined to assess divergent validity. There is a mild correlation between the Grit Scale and a Hopelessness Scale ($r = -.484, p < .001$). Furthermore the Pers, CtG and CI were negatively associated with the Hopelessness Scale ($r = -.372, -.375$ and $-.380$, respectively; all p 's $< .001$).

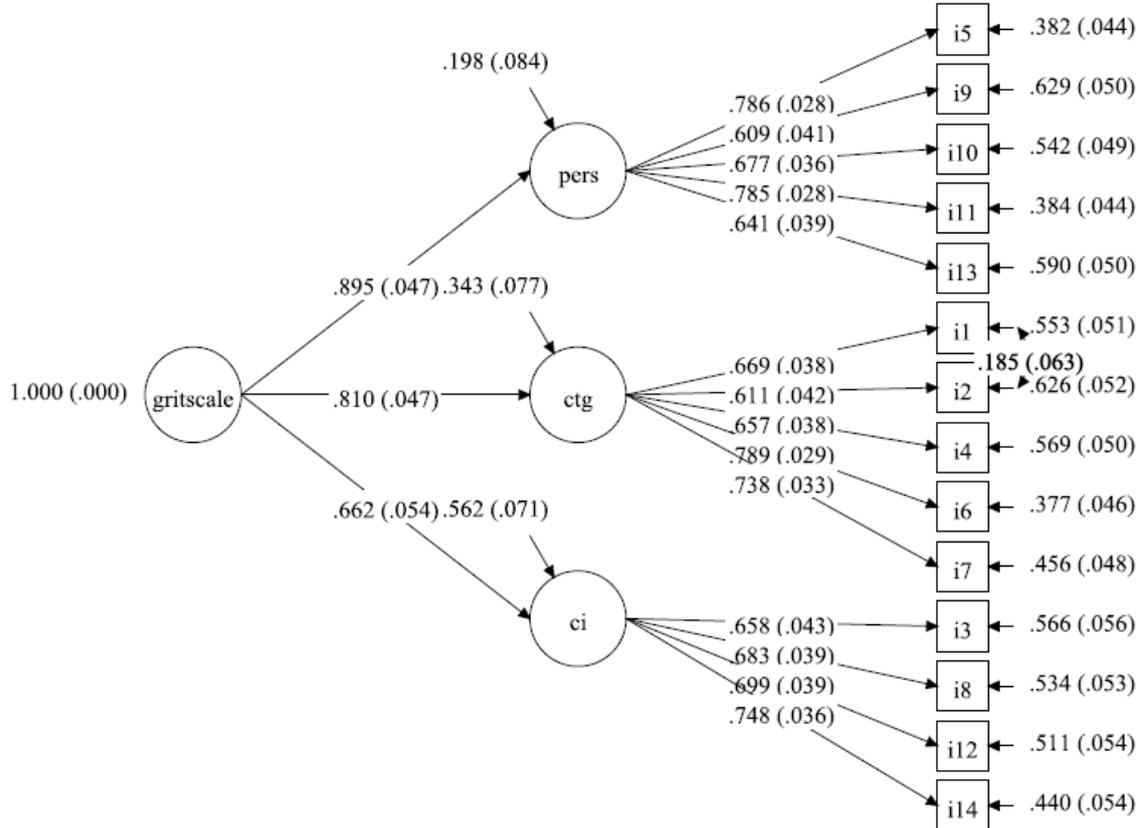
3.6. Measurement Invariance

Following the CFA test of model fit, measurement invariance was performed using multi-group CFA to examine the factor structure of the Grit Scale across two subgroups: high school students and university students. At first, the baseline models, estimated freely for both high school students and university students, demonstrated good fit (Figure 2 and 3). The results of the measurement invariance analysis are indicated in Table 3.



CtG= Commitment to Goal, Pers= Perseverance, CI= Consistency of Interest. All loadings are significant at $p < .001$.

Figure 2. The Factor Structure of the Grit Scale for High School Students.



CtG= Commitment to Goal, Pers= Perseverance, CI= Consistency of Interest. All loadings are significant at $p < .001$.

Figure 3. The Factor Structure of the Grit Scale for University Students.

After obtaining adequate fit indices for both group, parameters were gradually constrained and changes in fit indices were assessed. The configural model (M1), in which all parameters were unconstrained, had acceptable fit indices ($\chi^2=276.545$, $df= 146$, CFI= .96, TLI= .95, RMSEA= .055 [90% CI .045 to .065], Table 3). This result indicated that the three-factor model has well model fit across high school and university students group. In the metric model (M2), factor loadings were constrained to be equal, resulting in good model fit ($\chi^2=291.751$, $df= 157$, CFI= .96, TLI= .95, RMSEA= .054 [90% CI .044 to .063]). When compared to the M1, the chi-square difference test was non-significant and no significant changes in model fit indices occurred; $\Delta CFI= -.001$, $\Delta TLI= .001$, $\Delta RMSEA= -.001$. This result demonstrated that factor loadings were invariant across the group of high school and university students. To determine scalar invariance (M3), intercepts and factor loadings were constrained to be equal across group, which demonstrating a good model fit ($\chi^2=306.354$, $df= 168$, CFI= .95, TLI= .95, RMSEA= .053 [90% CI .043 to .062]). When compared to the M2, chi-square differences test was not significant and there was no significant deterioration of fit indices; occurred; $\Delta CFI= -.002$, $\Delta TLI= .003$, $\Delta RMSEA= -.001$. This showed that intercepts and factor loadings were invariant across the group of high school and university students. The results of measurement invariance analysis suggest that the Grit Scale can be comparable across the high school and university students groups.

Table 3. Fit Indices for Measurement Invariance Across the Group of High School and University Students

Model	χ^2	df	CFI	TLI	RMSEA	Mc	$p(\Delta\chi^2)$	ΔCFI	ΔTLI	$\Delta RMSEA$
B1	124.946	73	.962	.952	.050					
B2	151.599	73	.953	.941	.059					
M1	276.545	146	.957	.947	.055					
M2	291.751	157	.956	.948	.054	2 vs.1	.173	-.001	.001	.001
M3	306.354	168	.954	.951	.053	3 vs. 2	.201	.002	.003	.001

Note: B1= Baseline model for high school, B2= Baseline model for university, M1= Configural model, M2= Metric model, M3: Scalar model, Mc= Model comparison.

4. Conclusion and Discussion

This study, in which the Grit Scale was developed for high school students and university students, examined the measurement invariance of the scale in high school and university student groups. The exploratory factor analysis revealed a 14-item scale including three sub-dimensions: perseverance, commitment to goals, and consistency of interest. Confirmatory factor analysis also confirmed this construct. Considering the relationships of the Grit Scale with the other scales used in this study (Grit-S and Beck hopelessness scale) and the composite reliability and average variance extraction of the Grit scale, it can be said that the Grit scale has convergent and divergent validity. According to the reliability analysis, the scale provided reliable results. Besides, the Grit Scale had measurement invariance in high school and university student groups and had a similar structure in both groups. The Grit Scale was considered valid and reliable, consisting of three sub-dimensions and 14 items.

Unlike the two-dimension structure that Duckworth & Quinn (2009) presented, this study found that the concept of grit has a third dimension called as the commitment to goals. During the ongoing process of this study, we realized that another scale (Kuruveettissery, Gupta, & Rajan, 2021) was developed in India to measure grit. This three-dimensional grit scale was developed on Indian students and professionals aged between 18 and 25. These dimensions were named as; perseverance-commitment, interest-passion and goal-directed resilience. When comparing these structures, it is seen that these sub-dimensions have similar characteristics with the dimensions of perseverance, commitment to goals, and consistency of interest that we reached in our study. Besides, this reveals that the variable of grit is a culture-specific variable and the search for different structures in measuring grit continues in different countries. In the most general sense, grit (as a psychological construct) refers to passion and perseverance for long-term goals. Also, grit is a concept used in explaining the differences that occur in people's levels of using their potential (Duckworth et al., 2007). In the most general sense, the concept of grit is conceptualized as a hierarchical feature and considered as a two-dimensional construct. These constructs are Perseverance of Effort (PE) and Consistency of Interest (CI). PE refers to grappling with the difficulties encountered in pursuing tough goals, and CI involves a passionate commitment to goals. These constructs are common in the known and widely used measurement tools and in the first conceptualization studies related to grit (Cormier et al., 2019; Duckworth & Gross, 2014; Duckworth & Quinn, 2009). Grit is an important feature that affects individuals' worldviews and goals. Duckworth (2016)

states that a growth mindset can lead to grit. , A growth mindset about individuals' personalities and abilities, shape their worldviews, goals, and actions. Thus, individuals act differently to similar situations, and this is due to the individuals' having different beliefs. In other words, when individuals think that their efforts in a task are paying off, they set long-term goals and make a determined effort to achieve this goal (Dweck, 2017). However, the opposite is also true. Gritty individuals tend to engage in activities that improve their skills. Over time, these individuals develop mastery experiences by working hard and grappling with difficulties (Duckworth et al., 2011). This is because a change in behavior also accelerates the changes in the mindset. Although not empirically studied, passionate towards long-term goals can help individuals consider themselves flexible and capable. This situation emphasizes the importance of goals, goal setting, and commitment to goals in developing a sense of grit. Therefore, it is suggested that studies investigating intervention and measurement tool development should investigate issues of commitment to goals and achieving goals passionately (Park et al., 2020). Although goals are defined as the central components of grit, little attention has been paid to this issue in the grit scales existing in the literature. Goals have been neglected especially in measuring and discussing grit. Hence, research on the Grit Scale shows that only one item is about the goal statement (Duckworth & Quinn, 2009; Tang, Wang, et al., 2021). The Grit Scale developed by Duckworth and Quinn (2009) indicates that the item "*I often set a goal but later choose to pursue a different one*" is related to the goals. This situation is considered as a problematic situation both in conceptualizing and measuring grit. Especially in the Grit-S, there is a criticism towards naming two concepts such as Perseverance and Passion as a single factor by combining them with a medium level of relationship. Therefore, there is a call to develop and improve existing measurement tools regarding grit. In experimental research to be carried out to understand the role of grit better, the existing measurement tools are insufficient (Credé, 2018). The concept of goal in psychology has been examined in two dimensions. One of them is goal setting, and the other is goal implementation. Goal setting mostly reflects the direction of goal pursuit, while goal implementation reflects goal pursuit activation. The studies on grit have investigated goal implementation but neglected goal-setting processes (Tang, Wang, et al., 2021). In the literature, a study has been conducted with athletes considering grit as domain specific. In this study, the CI dimension was changed as the goal dimension and the expression "goal" was added next to the "project" expression in the items in this dimension. Thus, the statements were transformed into expressions of daily life for students and this dimension was associated with goals (Cormier et al., 2019). This situation points to the limitations in the current measurement tools. The existing measurement tools on grit do not have enough items related to the goals. This can be interpreted as a need for new measurement tools regarding grit.

Another theoretical explanation discusses the relationship between grit and goals by considering an example of grit and academic achievement. In this context, academic achievement is a long-term goal that requires students to take time and self-regulate to overcome difficulties. Therefore, grit encourages students to engage in academic tasks and results in higher achievement in students (Jiang et al., 2019). Achieving challenging goals such as being successful at school requires impulse control and the willingness to work hard and the ability to manage the emotions that arise while pursuing goals. Thus, intellectual/cognitive abilities, emotions, attributional styles, cognition, and self-regulation skills play an important role in academic success. Although no relationship was found between grit and academic achievement in a study conducted with high school students, there was a prediction between one's own chosen goals and grit.

On the contrary, no relationship was observed between grit and goals in which individuals may not be passionate about achieving (Ivcevic & Brackett, 2014). In studies conducted with adolescent, the PE dimension was found to be stronger in criterion-related validity than the CI dimension. Besides, the CI dimension was weaker than the PE dimension in predicting many outputs in adolescents (Bowman et al., 2015; Wolters & Hussain, 2015). Therefore, situations such as determining goals, focusing on goals and pursuing goals are important indicators of grit. These are also emphasized to be important features in developing adolescents' self-concept (Clark & Malecki, 2019). Similarly, in a study conducted with 1907 adults ($M_{age} = 41.4$) in different life periods (ages between 18 and 80), a positive and statistically significant relationship was found between goals defined in five dimensions of present and past (education, career, personal, relationships and health / Well-Being) and grit (Vazsonyi et al., 2019). A study conducted with 1296 adolescents in Finland examined the relationship between depressive symptoms, loneliness, and grit. In the study, grit was found to be the resilience factor against school burnout. Besides, it was concluded that grit decreased depressive symptoms in students with high levels of school burnout. This situation was observed to be more pronounced in male

adolescents. In other words, it was observed that grit had a more protective effect against depressive symptoms and loneliness in male adolescents at risk in school burnout when compared to female students (Tang, Upadyaya, et al., 2021).

Angela Duckworth, who has made a lot of research on grit, has contributed to conceptualizing and measuring the concept of grit as well as determining which variables it is related to. However, researchers are criticizing the GritScale developed by Duckworth et al. (2007) in the literature. Sturman and Zappala-Piemme (2017) criticize the Grit Scale for the following reasons: (i) younger students do not fully understand the expressions in the scale in terms of development because they require a high level of reading skill (e.g., "I have overcome setbacks to conquer an important challenge"), (ii) there is disagreement in the definition of the concept of grit (especially in the CI dimension) (e.g., the statement "My interests change from year to year" indicates the lack of grit). It is stated that multivariied interests should be considered as a positive situation rather than a lack of grit. The important thing here is that the person with a wide range of interests should follow one of their interests and have a life project to complete it. Thus, the researchers defined grit as "to sustain a focused effort to achieve success in a task, regardless of the challenges that present themselves, and the ability to overcome setbacks" and developed a measurement tool to measure grit in both adults and children. This 12-item scale is a 5-point Likert type measurement tool (1= Strongly Disagree, 5= Strongly Agree) and was developed to measure grit in children and adults. The scale was carried out with 249 students (from 3rd to 12th grades). The validity and reliability analysis reported that the 12-item scale had a single factor and was a valid and reliable measurement tool (alpha= 0.84-0.86, two-week test-retest reliability= 0.78). Based on the similar needs, this study aimed to develop a valid and reliable measurement tool for measuring grit in both high school and university students. Based on validity and reliability analyzes and evidence regarding measurement invariance, the developed scale is useful for high school and university students.

There are other criticisms of the Grit Scale developed by Duckworth. One of them is the lack of validity and reliability of the two-dimensional hierarchical structure conceptualized for the concept of grit. In this context, it is emphasized that the CI dimension is less related to grit in collectivist cultures when compared to the PE dimension. This was empirically tested in a study conducted with students attending high school (n= 220) and university (n= 606) in the Philippines, reflecting the collectivist culture's characteristics. In the study, the CI dimension was found to have a lower internal consistency coefficient than the PE dimension, and the PE dimension had higher correlations with basic psychological features such as positive affect, negative affect, academic engagement, and life satisfaction. This was interpreted as having a steady interest in long-term goals and not necessarily maintaining it to be defined as gritty (Datu et al., 2016).

Nonetheless, the concept of "context-sensitive self" is an important issue in collectivist cultures (Suh, 2007). Therefore, importance is attached to people's adaptation to the environment. As a result, it is stated that one of the reasons why people's interests remain unchanged over time may be due to this cultural feature. This is because individuals can determine their interests and goals in line with the group's expectations from time to time to maintain group harmony. Markus and Kitayama (1991) state that one of the basic characteristics of collectivist cultures is interpersonal harmony and pursuit of the group's goals. Another concern regarding grit is the situation in which grit can appear in different forms in different cultures. Researchers state that grit can have different definitions depending on the differentiation of cultural and social contexts. For example, in collectivist cultures where interdependence is important, relationships with family, friends, and peers lead to passionate commitment to long-term goals and persistence in achieving them. Thus, emphasis is placed on examining alternative models related to the concept of grit and developing ways of measuring it. It is especially important to realize these in different cultural contexts (Datu, 2017; Datu et al., 2017). In a study that aimed at conceptualizing grit in a cultural context, the definitions of ten Filipino university students regarding the concept of grit through their past life experiences were examined. In this study, the aim was to discover the cultural differences in the meanings attributed to the concept of grit, based on the collectivist cultural nature of the Philippines. The interviews displayed that grit had a triarchical structure. According to the themes obtained from the interviews, these structures have been named as the perseverance of effort, consistency of interests and adaptability to situations (Datu et al., 2018).

Grit is called "sisu" in Finland, which shows the typical features of the individualist culture. Grit (*sisu*) is explained as the determination of the person to overcome difficulties and is considered as a distinctive feature (hallmark). Thanks to grit, Finnish people have overcome the difficulties they faced in the past and have

become one of the happiest countries in the world by grappling with harsh climatic conditions. As in Finnish culture, the concept of grit can be observed in many different countries and cultural contexts. However, its definition differs from country to country or culture to culture. Also, traits associated with grit can vary according to cultural contexts.

For this reason, it is important to examine grit in different cultural contexts and replicate research on grit (Tang et al., 2019). Although grit has the characteristics of collectivist culture, it is defined in Turkey as (*azim*) "Determination to overcome the obstacles in a job" and gritty person (*azimli*) is defined as "Determined, resisting in her/his decision and attitude" (TDK, 2021). Thus, the person should be consistent and determined in features such as decisions, interests, attitudes, and important goals in their life. This definition is similar to the one in Finland, which reflects the characteristics of the individualist culture. However, it cannot be said that the characteristics of a fully collectivistic or individualist culture are clearly observed in Turkey. Studies show that common self-forms in Turkey reflect the characteristics of both individualistic and collectivist cultures. For Turkey, the autonomous-related self-construal has been defined. Therefore, it can be said that Turkey reflects the characteristics of both cultures (Kağıtçıbaşı, 2017). Thus, it can be said that the similarities in the dimensions and items of the measurement tool stem from cultural characteristics. As a matter of fact, it is seen that there is a similarity between the Grit-S developed by Duckworth and Quinn (2009) and the dimensions of this scale. It can be said that this similarity stems from the characteristics of the cultural context in question for Turkey.

5. Recommendations

The newly developed grit scale's validity and reliability were tested in various ways. According to results, the scale has good fit values, and it is a valid and reliable measurement tool that can be used in measuring grit. Accordingly, the developed measurement tool can be used on both adolescents and university students in studies on grit. Within the positive psychology approach framework, the issue of character strengths has become one of the widely researched topics in the literature. The number of theoretical and applied studies on determining, using and developing the character strengths of individuals is increasing rapidly. In this context, this developed scale can be used to research grit character strength. On the other hand, grit is an important feature for students' development processes as a non-cognitive skill. It is thought that it is important to use this scale in this context.

This study has some limitations. First, the scale was carried out on high school and university students and in the Turkish sample. To investigate the generalizability of the scale, studies with samples other than the student group and in other cultures are needed. Second, almost all measurement tools developed to measure non-cognitive properties such as grit are paper-and-pencil tests. To eliminate this limitation, other methods can be developed to measure grit. Research prefers longitudinal methods to measure grit because in this way they could examine the change in grit over time (Luo et al., 2020). However, this study was carried out with a cross-sectional method. Based on this limitation, it may be beneficial to conduct future studies with a longitudinal method by focusing on different age groups in society. In addition, the participants' responses to the scale items may have been affected by social desirability. After that, case examples about grit can be used in the scale development studies to be carried out on grit. The Grit Scale developed in this study mainly was evaluated as a valid and reliable tool in measuring the grit levels of the students. However, the concept of grit is not just a valid concept for school or educational settings. Grit has also been adapted to work and organizational psychology and employee behavior.

Because no measurement tool has been found in determining the grit levels of employees in Turkey. This shows that there is a need for a measurement tool for grit in workplace. For this reason, it may be useful to examine the psychometric properties of the developed Grit Scale in people in different works and workplaces.

6. References

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Appendix:

GRİT SCALE (AZİM ÖLÇEĞİ)

	MADDELER	Kesinlikle Katılmıyorum	Katılmıyorum	Kararsızım	Katılıyorum	Kesinlikle Katılıyorum
1	Kendimi hedeflerime adarım	1	2	3	4	5
2	Hayallerimin peşinden giderim	1	2	3	4	5
3	Bin bir hevesle belirlediğim hedeflerimden kısa sürede vazgeçerim*	1	2	3	4	5
4	Hedeflerim beni cesaretlendirir	1	2	3	4	5
5	Ne olursa olsun önüme çıkan engellerle mücadele eder, onları aşmaya çalışırım	1	2	3	4	5
6	Sonuna kadar çabalamaya devam ederim	1	2	3	4	5
7	Bir hedefim olduğunda tüm varlığımla ona odaklanırım	1	2	3	4	5
8	Sık sık hedeflerimden vazgeçer, onları değiştirip hedefler belirlerim*	1	2	3	4	5
9	Engellerle karşılaştığımda karamsarlığa kapılmam	1	2	3	4	5
10	Zorluklara ve engellere rağmen yapmam gerekeni yapmaya devam ederim	1	2	3	4	5
11	Zorluklar karşısında kolay kolay pes etmem	1	2	3	4	5
12	İstekle başladığım birçok işte çabucak hevesim kırılır*	1	2	3	4	5
13	Engeller ve zorluklar beni yolumdan alıkoyamaz	1	2	3	4	5
14	Hedeflerim ve ilgi alanlarım çok sık değişir*	1	2	3	4	5

1. *Perseverance (Zorluk ve engellerle mücadele)*: 5, 9, 10, 11, 13

2. *Consistency of Interest (İlgi ve hedeflerin tutarlılığı)*: 3, 8, 12, 14

3. *Commitment to Goals (Hedeflere adanma ve bağlılık)*: 1, 2, 4, 6, 7

* Reverse-coding items (Tersten puanlanacak maddeler) (3, 8, 12, 14)