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The Cognitive-affective Distinction in Achievement Goal: The Development and Validation of the Achievement Questionnaire for Biology Learning

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ABSTRACT

K-8 science teacher candidates often struggle with the difficult learning tasks in multiple science courses in their teacher-training program. One of the major parts of these science courses is biology. Student learning in biology depends on their motivational and affective variables as much as their cognitive abilities. As one of the theories of motivation, the achievement goal theory seeks how individuals pursue academic study by focusing on mastery or performance goals. In addition to goal settings, achievement emotions also influence learners' academic performance. The authors suggested a theoretical model integrating achievement emotions into the construct of achievement goal theory. The present study has potential provide more insight into individual differences in goal preferences. This model was examined with K-8 science teacher candidates (n = 581). To test the theoretical model, the "Achievement Goal Questionnaire for Biology Learning" (AGQ-BL) was devised. According to the theoretical model, the AGQ-BL consisted of six subscales which are Mastery Goals-(affective-cognitive), Performance Goals-Approach (Affective-Cognitive), and Performance Goals Avoidance-(affective-cognitive). The explanatory factor analysis (EFA) and confirmatory factor analysis (CFA) were utilized to verify the construct validity of the AGQ-BL. The results of EFA showed and CFA confirmed that the AGQ-BL was composed of six factors, as proposed by the theoretical framework. Internal consistency of the subscales of the AGQ-BL computed by Cronbach's alpha revealed high reliability for each. This study empirically demonstrated the integration of cognitive and emotional goals in achievement settings regarding biology learning. Thus, it can be asserted achievement goals' structure could have more predictive potential on affective and cognitive variables in biology education.

KEY WORDS: Achievement emotions; achievement goals; biology learning; K8-science teacher candidates

INTRODUCTION

Students of different levels experience various learning difficulties in the study of biology. Researchers have attributed the learning difficulties in biology to instructional and curricular constraints, the abstract nature of biological concepts, and the complex relationships between them (Bahar et al., 1999; Çimer, 2012). Naturally, the study of these concepts constitutes a complex learning task and requires persistence. Besides cognitive abilities, students require additional qualities, such as motivation, interest in the subject matter, and a positive attitude, to achieve high levels of learning and persistence in studying. However, individual differences in learning observed between students cannot be entirely attributed to the differences in their cognitive ability. These divergences should be explained as the result of the involved and dynamic interplay between students' cognitive, affective, and motivational characteristics (Volet, 1997; Mega et al., 2014; Hayat et al., 2020).

In particular, motivation is decisive in affecting students' learning levels and their study persistence. This assertion is supported by some studies. For instance, Lee and Brophy (1996) and Pintrich et al. (1993) indicated that motivation plays a key role in conceptual change. Moreover, students with higher motivation levels show higher attention in the classroom, more willingness to participate in activities, and a stronger desire to ask questions (Pajares, 1996; Wolters and Rosenthal, 2000; Schunk and Pajares, 2001). In the context of a constructivist approach to learning, science education and the study of biology require the interaction between cognition and affection (Tuan et al., 2005). From this point of view, motivational beliefs are an important factor in the learning process in determining the students' achievements and failures. For that reason, motivation has caught researchers' attention for some time.

One of this research's main interests was the development of measurement tools to determine individual's motivations or motivational beliefs. In the literature, few studies have used measurement tools to determine motivation in biology learning (e.g., Başer, 2007; Ekici, 2009; Shihusa and Keraro, 2009; Wilde et al., 2012; Aydin et al., 2014; Kışoğlu, 2018). In contrast, there are several examples of learning motivation scales for science education (Tuan et al., 2005; Glynn et al., 2009; Fortus and Vedder-Weiss, 2014; Lin and Tsai, 2017; You et al., 2018). As stressed by Velayutham et al. (2011), researchers in educational studies mostly adopt the context-free theoretical framework regarding thought and behavior in their educational context, especially in the field of achievement motivation. In addition, these authors indicated theoretically unsound construction of some of the motivation scales for science learning, for instance, developed by Glynn et al. (2009), Glynn and Koballa (2006), and Tuan et al. (2005) some of which were adapted into Turkish. Notably, Aydin et al. (2014) pointed out that current scales used for the study of biology were not subject-specific and criticized the adaptation studies of motivation scales regarding biology learning, by stating that researchers have changed the wording. For instance, Ekici (2009), one of the criticized studies, relabelled the "Science Motivation Questionnaire" developed by Glynn and Koballa (2006) as the "Motivation for Biology Course Questionnaire." Further, Başer (2007) adapted into Turkish the scale developed by Tuan et al., (2005) and named it "Motivation towards Learning Biology Questionnaire." In reality, the main aim of Başer's study was to determine the contributions of learning motivation, reasoning ability, learning orientation, and gender to International Baccalaureate and National Program students' understanding of mitosis and meiosis. For this reason, the researcher had to adapt the scale in a rapid and simple manner. Similarly, Shihusa and Keraro (2009) developed a motivation scale which aimed to assess the level of motivation to learn the biology of two groups of students. Indeed, in this study, the real aim was to determine the effect of using the advanced organizer teaching strategy on biology learning motivation in comparison to the classical methods. The researchers did not report any psychometric properties of this scale, except for Cronbach's alpha value. Moreover, they did not provide any sample items from this scale. These superficial adaptation efforts highlight the inadequacy of the current measurement tools adopted for the study of biology education.

The study of Aydin et al. (2014) was an attempt to correct this deficit since they developed a scale based on the theoretically sound construct. The authors developed a scale, the "Academic Motivation Scale for Learning Biology (AMSLB)," for estimating the motivation of secondary school students. This scale was based on the theory of self-determination. Thereafter, Yerdelen et al. (2014) conducted a study to determine the relationship between achievement goal orientation and motivation. In accordance with the aim of their study, they used AMSLB (Aydin et al., 2014) and the "Achievement Goal Orientation" questionnaire developed by Elliot and McGregor (2001). In the study of Yerdelen et al. (2014), this questionnaire was used to determine the secondary school students' achievement goal orientation. Again, researchers adapted the questionnaire for biology.

After reviewing the literature for the study of motivation and motivational beliefs in biology education, we concluded that most studies adopted unspecific and superficial adaptations of measurement tools. Consequently, there has not been any measurement tool designed to evaluate the learners' goal orientation for the subject of biology. In this sense, we are interested in learners' goal orientations regarding being successful in biology.

Motivation Theories

At the beginning of the 20th century, the theories framed motivation as instinct, need, drive, or incentive. In recent theories, particularly in the scope of academic achievement, motivation is evaluated as an individual's beliefs, thoughts, and emotions but also involves the interactions between an individual and a larger social context (Cook and Artino, 2016). According to Pintrich and Groot (1990), the conceptualisation of students' motivation is an adjustment of a general expectancy-value model of motivation. Atkinson was the first developer of the formal expectancy-value model in the scope of motivation in achievement situations. His theoretical structure consisted of probability of success (expectancy of success), incentive value, and motives (e.g., Atkinson, 1964, 1966). Expectancies are defined as beliefs and judgments about individual's abilities to perform tasks successfully, while values point to an individual's beliefs regarding the reasons which them led to engage in certain tasks. (Wigfield and Eccles, 1992; Wigfield et al., 2009; Schunk et al., 2014). Pintrich and Groot (1990) grouped the recent motivational theories. The researchers listed the components of this model as (a) expectancy which refers the self-efficacy, perceived, competence, attributional style, and control beliefs, (b) value which involves students' goals for the task and their beliefs about the importance and interest of the task, and (c) affective factors which indicate learners' emotional responses to the tasks. In the other review study, Eccles and Wigfield (2002) have grouped the theories into three major families. The first family focused on individuals' perceptions about their ability, in other words, expectancies for success. It includes theories such as self-efficacy theory and control theory. The self-efficacy theory is the most influential model on academic success and is widely used. Bandura (1997) proposed the theoretical construct with two components: Efficacy-and outcome expectation. Bandura defined efficacy expectation as one's beliefs about the efficacy to perform a certain task while he proposed outcome expectancy which refers to beliefs that certain behaviours will lead to certain outcomes. The second family focused on theories that consolidate expectancies and values. It includes theories such as attribution theory, and the expectancy-value models of Eccles et al. The construction of the contemporary expectancy-value model relied on the works of Eccles, Wigfield et al (Schunk et al., 2014). Eccles and Wigfield (2020) have broadened the model and added a developmental point of view to both expectancy and values in life trajectories associated with these beliefs over childhood and adolescence. The last family focused on an individual's reasons for engaging in a task or task value. It encompasses theories such as self-determination theory, interest, and goal theories. The attribution theory emphasizes that students perceive the cause of their learning outcomes as influencing motivation. The self-determination theory proposes that learning is defined by the relationship between intrinsic motivation, which concerns the students' inclinations and extrinsic motivation, which is driven by social norms. Finally, the goal orientation theory emphasizes the importance of students' self-expression as the motivation for success (Cook and Artino, 2016). Specifically, goal orientations are motivational beliefs determined by the implicit self-theories regarding the learners' abilities (Dweck and Leggett, 1988).

Goal setting should be a decisive factor in determining a student's academic success. For instance, Atasoy (2015) demonstrated that mastery goals, whereby students are motivated by the intrinsic value of learning predict the adoption of metacognitive strategies (i.e., methods which focus on understanding the learning process), which influence students' learning level. Similarly, Pintrich (2000b) stressed that those goal settings should determine students' study experiences in terms of affect and strategy use. Even during the early childhood stage, mastery motivation is a more powerful predictor of school success than academic skills, such as literacy and numeracy (Józsa and Barrett, 2018).

In this study, we aimed to develop a motivation scale based on the goal orientation theory. Since the learners' goals motivate them and, thus, shape their way of learning.

Achievement goals

In the 1940s and 1950s, achievement goal was already formulated as both a desire for achievement and to avoid failure (e.g., Lewin et al., 1944; McClelland, 1951; Atkinson, 1957) although the pioneers of the achievement motivation theory established the approach-avoidance distinction in the theoretical framework their followers have overlooked this distinction. In the 1980s, the formulation of achievement goals was transformed into two opposing constructs, named differently by separate researchers (Ames, 1992; Elliot, 1999; Urdan and Kaplan, 2020): Learning versus performance (Dweck, 1986); task-involvement versus ego-involvement (Maehr and Nicholls, 1980); and mastery and performance goals (Ames and Archer, 1987). Specifically, in the context of intellectual achievement, the former-learning goals, task involvement, and mastery goals-concerns individuals increasing their competence, while the latter-ego-involvement and performance goals-relate to gaining favorable evaluation of their competence (Ames, 1992; Dweck and Leggett, 1988). Elliot and Harackiewicz, (1996) expanded this dichotomy in theoretical structure as approach avoidance distinction was integrated into the performance construct so it was established trichotomous structure: These three goal types were mastery, performance-approach, and performance-avoidance. They argued that mastery goals are expected to have a uniform effect across levels of perceived competence while performance goals should have variation according to having high or low levels of perceived competence. The researchers have defined the performance-approach as a set of goals aimed at the demonstration of competence and performance-avoidance as a set of goals aimed at avoiding the demonstration of incompetence. Elliot (1999) and Pintrich (2000a) have suggested including the approach-avoidance also into the mastery goal construct. Thus, the integration of mastery-approach and mastery avoidance the trichotomous structure of the theory was modified to four component structure. Elliot (1999) has also proposed theoretically a matrix model which labeled as 2 × 2: Two (2) for mastery-performance and other two (2) for approach-avoidance distinctions. To contrasting approach and avoidance difference, the researchers have used valance; positive valance means approaching success and negative valance means avoiding failure. In this direction, goal models were described as 2 × 2. Thereafter, the same construct evolved into 3 × 2, in which mastery-oriented goals bifurcated into separate task-based and self-based categories (Elliot et al., 2011; Mascret et al., 2017).

In the present study, we adopted the theoretical framework constructed in the model of trichotomy. Accordingly, the mastery and performance distinction were the main constructs. In particular, the mastery goal construct was assumed as uniform in the context of approach-avoidance while the approach-avoidance distinction was valid for performance goals. In the performance goals with approach and avoidance categories are bifurcated into cognitive and affective (Figure 1). The framework of the present study is based on Boekaerts' motivation studies. Boekaerts (1987, 1992, 1996) evaluated the cognitive and affective impact of the study on students and the effect of subjective cognitions and emotions on the effort and energy invested in learning. Furthermore, she identified two learning goals, namely acquiring more knowledge and competence, and maintaining or restoring positive affective states (Boekaerts, 1988). Finally, she stressed that most motivation researchers have tended to study motivation with little attention to the influence of appraisals, emotions, and current concerns on the learning process (Boekaerts, 2001). There are three lines of research that highlight the connection between achievement goals and affective experience. One of

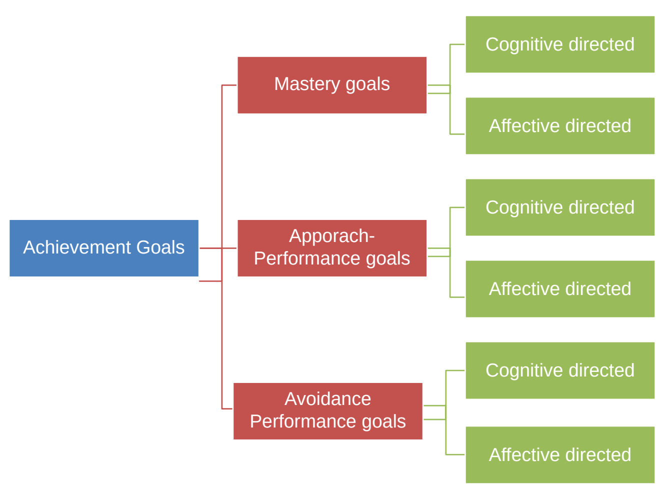

Figure 1: The theoretical framework of the study

these research lines has focused on challenge/threat affect, the other one has stressed test anxiety. The most recent group of research has focused on the emotions experienced generally in achievement situations (Elliot and Pekrun, 2007).

As reflected by Elliot and Thrash (2001), students' achievement or learning-related behaviours are guided by their achievement goals, which are cognitive presentations of their competence however, students' behaviours are guided by their emotions additionally. However, traditionally, research in higher education has given little attention to achievement emotions, except for test anxiety (Pekrun et al., 2002; Pekrun and Stephens, 2010). However, in recent years, it can be said that more researchers work more with the multiple emotions in academic settings (Pekrun, 2019). As Pekrun et al. (2017) have demonstrated, academic emotions and achievement are mutually related.

Finally, the aim of this study was the development of an instrument of Achievement Goals Questionnaire for Biology learning.

METHODS

As stated before, the main purpose of the study was to develop a scale assessing students' achievement goals regarding to biology learning. For the scale development, both qualitative and quantitative research strategies were utilized. The scale development procedures involved the following: (i) defining the construct being measured, (ii) generation of an item pool, (iii) expert views on the initial item pool, (iv) refinement and validation of the scale, and (v) evaluation of the scale with statistical methods (Netemeyer et al., 2003; Worthington and Whittaker, 2006; DeVellis, 2016).

Participants

In this research, the target population was defined as all undergraduate university students of K-8 science teacher programs pursuing science courses in educational faculties in Turkey. The participants were recruited using the convenience sampling method. The sample consisted of 581 undergraduate students from four different universities in Turkey. Of the participants, 81% were female and 19% were male students. When analysing the participants' grade levels, there were 17.4% freshmen, 24.4% in the second grade, 28.9% in the third grade, and 29.3% were senior students. While determining the sample size, Kline's (2011) recommendations and acceptable threshold for the explanatory factor analysis (EFA) and confirmatory factor analysis (CFA) were considered (Hair et al., 2010). The scale was administered to the participants who consented to participate after they were informed about the goal of the study. The measurement tool was applied to the students who volunteered after obtaining permission from the administrations of the faculties where the study was carried out. The application was done at the end of the lesson and at the beginning, information about the purpose of the measurement tool was given and the form was distributed to those who volunteered.

Item Generation

The development of the "Achievement Goal Questionnaire for Biology Learning (AGQ-BL)" commenced with the definition of the conceptual framework of the study, in which goal orientation theory was taken as the baseline. The researchers reviewed the relevant literature and the items were developed based on the achievement goal theory, which investigated the reasons of people's behaviours in achievement settings. The five-point Likert scaling ranged from strongly agree = 5, agree = 4, undecided = 3, disagree = 2, to strongly disagree = 1 was preferred. Subsequently, an item pool was generated including 25 items.

The item development process was based on the theoretical framework according to the trichotomous conceptualisation of achievement goals. In this framework, the performance goals were distinguished between approach and avoidance. While the mastery goal items were drafted, the distinction of approach-avoidance was not implemented. Instead, mastery items were constructed according to the cognitive-affective distinction. The cognitive items reflect the distinction of approach-avoidance was performed-performance approach and Performance avoidance goals. Additionally, items were drafted based on the measurement of the cognitive and affective dichotomy (Figure 1).

According to the theoretical framework of the study, the "Achievement Goals Scale for Biology Learning (AGQ-BL)" consisted of six subscales which are Mastery Goals-Affective (MG-Affective), Mastery Goals-Cognitive MG-Cognitive), Performance Goals-approach Affective (PGAppr-Affective), Performance Goals Approach-Cognitive (PGAppr-Cognitive) Performance Goals Avoidance-Affective (PGAvoid-Affective), Performance Goals Avoidance-Cognitive (PGAvoid-Cognitive). The Items and their distribution into subscales can be found in the Appendix.

Evidently, learning processes should be interpreted by cognitive and emotional variables. The past experiences, i.e., the learners' success-and-failure history in relation to academic tasks, contribute to their perceptions and emotions regarding the encountered learning activities or academic tasks. The appraisal of learning activities and their outcomes is executed in cognitive and affective approaches (Boekaerts, 1988). From this point of view, it can be argued that learners appraise their learning orientation or learning goals according to their cognitive and affective functioning. In this study, the cognitive appraisals of learning goals reflect one's perceptions regarding targeted outcomes, which could be achieved through certain learning activities. These activities can be regarded as mastery or performance goals. An example of an item from the cognitive-directed mastery goal was "I study biology to learn the mechanism underlying the world of living things." Here, the item represents an aim determined cognitively. However, an affective-directed example item from mastery goal was "I study biology as I enjoy learning the mechanism underlying the world of living things."

After preparing the item pool, in order to investigate the content and face validity of the scale, the scale was presented to three experts to gather their views about the items and the theory. The experts who held doctorates in the field of science, education, and psychology were asked to identify any ambiguity, vagueness, or contradictory meanings of the items. The experts were requested to choose one of the options "Suitable," "Modify," and "Delete/Not suitable" for each item of the scale. In the evaluation of the expert opinions for the scale items, firstly, the items that all experts defined as appropriate were determined. In addition, the items on which all experts agreed to be modified were revised and presented to the expert opinion again. It has been determined that these items represent an adequate structure within the theoretical framework. For this reason, the items on which there was no agreement on the appropriateness of the experts were not included in the scale. Accordingly, the items were organized in a scale form to administer as a pre-test.

Data Analyses

For the data analysis, first of all, the items were scored based on the Likert scaling method. The minimum point of the scale is 25 and the maximum score is 125. No cut score was determined in order to interpret the motivation of the participants; however, the higher scores indicate the higher motivation. The scale was composed of six sub-dimensions and as well as total scores, the scores of the sub-dimensions were also calculated for further analyses.

Before investigating the reliability and validity properties of the developed scale, data set was investigated based on the assumptions of these techniques. The data set was checked in terms of normality, outliers, linearity, and missing values. Z scores and Mahalanobis distances were calculated for univariate and multivariate outliers respectively. Few univariate outliers were identified as having z scores higher than 3 and these cases were removed from the dataset. No multivariate outliers were detected. The normality of the items was investigated with skewness and kurtosis values both at item and total score levels. Skewness and kurtosis describe the shape of the distribution so that normality may be assessed (Tabachnick and Fidell, 2007). The skewness and kurtosis values of the items ranged from −1.357 to 1.383 and from −1.139 to 0.462 respectively. It was found that the values are within acceptable ranges, as suggested by Tabachnick and Fidell (2014). In addition, Kline (2011) asserted that the absolute value of Skewness >3 and the Kurtosis value >10 may indicate an issue in the normality of the data. These results showed that the data were normally distributed. As for missing values, there were missing values <5% of the sample and had random patterns, so these patterns (f = 12) were excluded from the dataset.

After the preliminary analyses, the scale development continued, involving item analyses. The descriptive statistics and item parameters of popularity and discrimination were calculated. These analyses were based on Classical Test Theory. For these analyses, SPSS 22.0 was utilized.

After calculating the items' popularity and discrimination parameters, the validity and reliability analyses were conducted. To discover the factorial structure of the scale, EFA was conducted. For EFA, 250 participants' data were selected randomly from the whole dataset and then the requirements of EFA were tested via the Kaiser-Meyer Olkin and Barlett Test of Sphericity. Based on these tests, it was found that the sample size was suitable for EFA. The EFA was applied using the Principal axis technique and the oblique rotation method was applied too. In the EFA, the threshold value for item factor loadings is accepted as 0.32 as proposed by Tabachnick and Fidell (2014). Regarding cross-loading, it is recommended to discard items with loading values in more than one factor with values of 0.32 or more (Costello and Osborne, 2005).

After defining the factorial structure of the scale using the results of EFA and theoretical background, the validity of the factor structure of the scale was tested with CFA. CFA is one of the most effective ways of assessing whether a pre-defined factor model fits the data (Floyd and Widaman, 1995; Netemeyer et al., 2003). This analysis was regarded as the well-known statistical procedure for examining a hypothesized measurement model (Byrne, 2001). For CFA, a sample composed of 300 participants whose data were not used for EFA was used. The CFA was performed by using LISREL 8.70. While determining the sample size for the CFA, the values proposed by Lee (2007) were considered. According to Lee (2007), the sample size of 50 is excessively weak, 100 is weak, 200 is moderate, 300 is satisfactory, 500 is very good, and 1000 is excellent for CFA. The Maximum Likelihood estimation method was employed.

In CFA, the model fit of the data is evaluated using many statistical procedures and in this study, the most prevalent statistics were used, including the Chi-square Goodness Test, goodness of fit index (GFI), Adjusted GFI (AGFI), Comparative fit index (CFI), and root mean square error of approximation (RMSEA). There are some thresholds taken into account while determining the model fit: Being >0.90 for GFI, AGFI, and CFI and <0.08 for RMSEA (Tabachnick and Fidell, 2001; Kline, 2011). As for reliability, the internal consistency was investigated not only for the whole scale but also for sub-dimensions.

RESULTS

EFA

Prior to the application of PCA, the assumptions of EFA were checked to determine the appropriateness of the data. Firstly, Bartlett's Test of Sphericity was performed and the results were statistically significant ($\rho < 0.001$); hence, it was concluded that the dataset is suitable for factorization. Then Kaiser-Meyer-Olkin value was estimated to be 0.88, exceeding the recommended value of 0.60 (Kaiser, 1974). It was concluded that the sample size is satisfactory for the analysis. All this indicates that EFA can be applied to the dataset and so, the PCA was then conducted with the dataset.

The result of PCA showed that there were four factors with eigenvalues higher than 1, explaining a reasonable percent of the variance (67.8% cumulatively). Additionally, the scree plot was analysed and it was found that the slope of the plot disappeared after the sixth factor. Based on the scree-plot and theories used in scale development, six factors were retained for further investigation. The six-factor solution of the scale was tested again using the varimax rotation method. When the factor loadings were investigated, five items were detected that have high factor loadings at two separate factors at the same time hence, these items were discarded from the scale regarding their factor loadings levels. The remaining 20 items had high factor values, and so the scale was accepted as a six-factor scale as the theoretical framework of the study supported it. The item loadings of the scale are presented in Table 1.

On analyzing the explained variance ratios, the first factor alone explained 18.8% of the total variance. The second, third, and fourth factors contributed to 15.79%, 13.49%, and 11.88% of the six-factor structure, respectively. For the last two factors' explained variance ratios were found as 11.24 and 4.81 and it was found that the total variance of the six factors structure explained 76.03% of latent variables' variance.

Based on the results, it was decided that the scale comprises of six factors and the items in the separate factors were found to be consistent with the theories that were used in the development of the scale. Therefore, the factors were named by considering the items and theories accordingly; factor 1 is labelled as Performance Goals Avoidance-Cognitive (PGAvoid-Cognitive), factor 2 as Mastery Goals-Affective (MG-Affective), factor 3 as Mastery Goals-Cognitive (MG-Cognitive), Factor 4 as Performance Goals-Approach Affective (PGAppr-affective), Factor 5 as Performance Goals Approach-Cognitive (PGAppr-Cognitive), and factor 6 as Performance Goals Avoidance-Affective (PGAvoid-Affective).

CFA

In CFA, the six-factor solution obtained from EFA was tested and the first finding of the CFA was the path diagram showing the standardized coefficients and which is given in Figure 2.

In Figure 2, linear relationships between latent and observed variables are seen. The t-values were analysed for the variables, and it was found that all the t-values were between 12.61 and 24.06. All t-values were significant at 0.01 level. This means that all the items are significant predictors of the latent structure proposed by the EFA. After evaluating the t-values, standardized factor loadings were investigated. These values are given in Table 2.

Table 2 presents the standardized factor loadings of items and the explained variance ratio of observed variables for the measurement model. When examining the standardized factor loadings, it was found that nearly all the values were higher than 0.50. The highest value was estimated for item 13, at 0.92, and the lowest for item 6, at 0.60. As for explained variance ratios, these values were high too, depending on the standardized coefficients. The higher standardized coefficients implied lower error variance; hence it shows that latent variables were explained by observed variables at high rates.

Table 1: Factorial structure and items' factor loadings after rotation

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
Item 18	0.851					
Item 25	0.845					
Item 23	0.814					
Item 2		0.861				
Item 1		0.840				
Item 3		0.837				
Item 7			0.625			
Item 8			0.802			
Item 6			0.799			
Item 9			0.677			
Item 11			0.595			
Item 14				0.860		
Item 13				0.839		
Item 12				0.766		
Item 17					0.834	
Item 16					0.809	
Item 18					0.721	
Item 20						0.744
Item 21						0.704
Item 19						0.548
Explained variance %	18.81	15.79	13.49	11.88	11.24	4.81

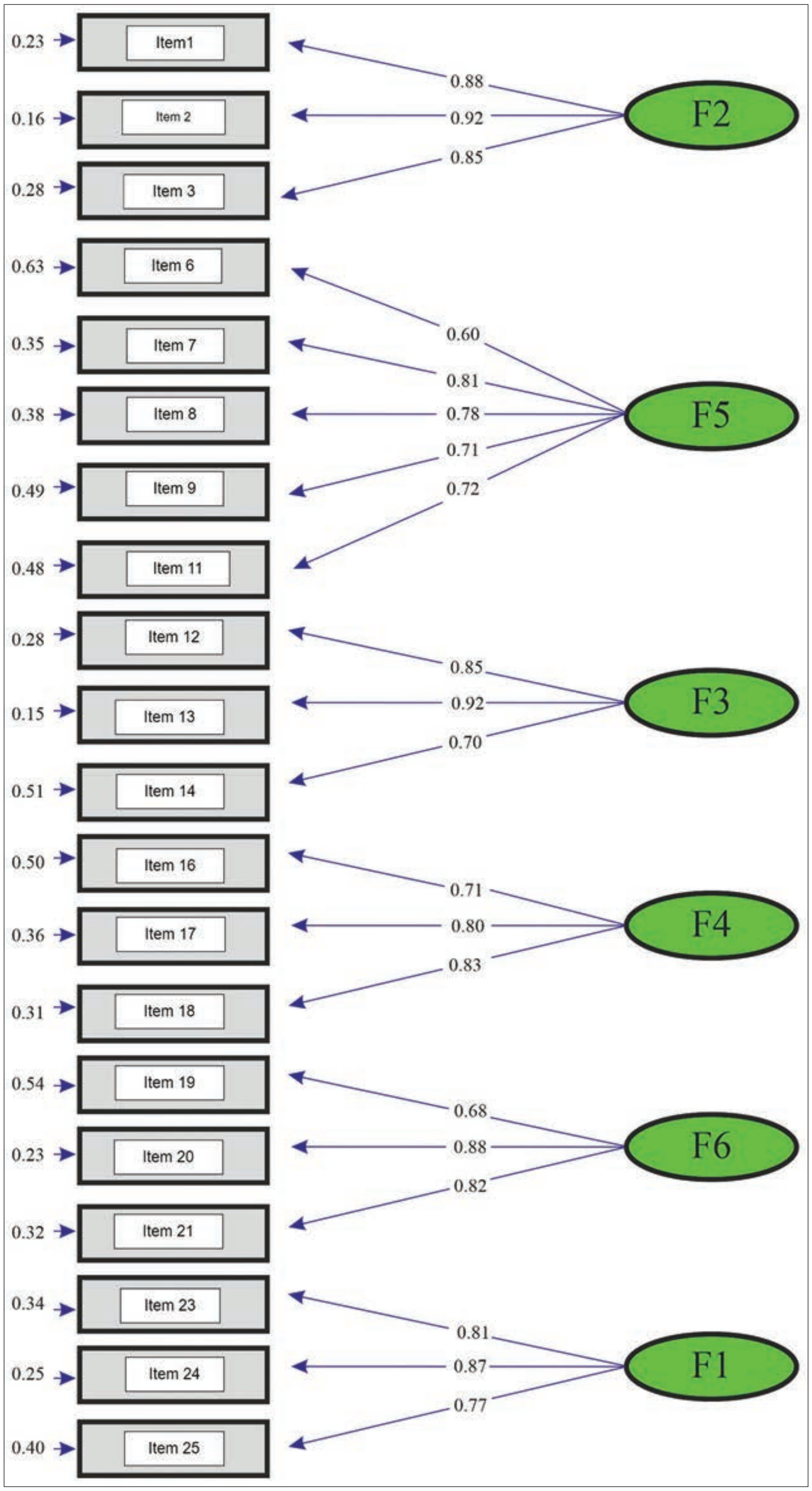

Figure 2: The path diagram of the first-order confirmatory factor analysis

After checking item statistics of the measured models, general model fit indexes were investigated. Firstly, the ρ-value of the measurement model was analyzed and found significant at 0.01 level and this finding indicated that the p-value shows that there is a significant fit with the proposed measurement model and data set. In addition to the ρ-value, other statistics show the model fit, a Chi-square is one of them. The Chi-square value is recommended to be evaluated with the degrees of freedom (Jöroskog and Sörbom, 1993; Thompson, 2004). Hence, the estimated Chi-square, 565.54, was divided into its degrees of freedom value, and it was found as 3.65. The ratio of Chi-square and degrees of freedom was found lower than

Table 2: Standardized factor loadings and explained variance ratios of the measurement model

Factor 1			Factor 2			Factor 3		
Item No	Λ	R^2	Item No	λ	R^2	Item No	λ	R^2
23	0.81	0.77	2	0.92	0.82	14	0.70	0.49
24	0.87	0.75	3	0.85	0.73	13	0.92	0.85
25	0.77	0.60	1	0.88	0.75	12	0.85	0.72
Factor 4			**Factor 5**			**Factor 6**		
Item No	λ	R^2	Item No	λ	R^2	Item No	λ	R^2
17	0.80	0.64	6	0.60	0.39	20	0.88	0.77
16	0.71	0.50	8	0.78	0.65	19	0.68	0.46
18	0.83	0.69	9	0.71	0.50	21	0.82	0.68
			11	0.72	0.55			
			7	0.81	0.51			

5, which is the critical value, and it shows that the model fit is satisfactory level (Sümer, 2000; Schermelleh-Engel et al., 2003). We checked over the indexes from the CFA outputs to examine the model fit: The examined indexes were RMSEA, Jöreskog-Sörbom GFI, Bentler CFI, and SRMR. The purpose of using these four indexes was to state the grade of model fitness with the data (Kline, 2011). Especially, as the fit between the model and the data increases, the RMSEA value decreases towards zero. The customary cut-off value is 0.06 for RMSEA (Kline, 2011). The GFI represents the covariance ratio in the sample described by the model (Kline, 2011). The increasing GFI value of a model indicates that it covers more inter relationship among variables. In the literature, a GFI value of 0.90 or higher frequently accepted as an indicator of good fit. CFI estimates advancement of fitness of a theoretical model as compared to a baseline model, which commonly presumes zero covariance among the observed variables. A cut-off value of 0.95 or bigger usually shows a good model fit. SRMR is an overall estimation of the mean absolute correlation residual between sample correlations and the model-predicted correlations. Usually accepted threshold of 0.08 or low shows a good fit between sample correlations and the model estimated correlations (Kline, 2011). The threshold values suggested by Schermelleh-Engel et al. (2003) are presented in Table 3 for these indexes.

Considering the model fit indexes, the calculated values for the Scale of Motivation for Teaching Biology were reported in the Table 4.

We examined the model fit indexes for the proposed model; GFI was calculated to be 0.91, showing the acceptable level of model fit. Like GFI, AGFI was estimated at 0.88, somewhat lower than the thresholds. The SRMR (0.057) and RMSEA (0.07) were estimated to be within the thresholds indicating the medium level of model fit. The other statistics, IFI and CFI were found to be higher than 0.95, indicating a high model fit. When the indexes and item loadings are evaluated together, the model fit was at a moderate level. Moreover, the modifications suggested by the analysis were analyzed too; however, it was

Table 3: The indexes thresholds used in the evaluation of model-data fit

Model-data fit indexes	Good fit	Acceptable fit
RMSEA	$0<RMSEA<0.05$	$0.05<RMSEA<0.10$
SRMR	$0\leq SRMR\leq 0.05$	$0.05\leq SRMR\leq 0.10$
NFI	$0.95\leq NFI\leq 1$	$0.90\leq NFI\leq 0.95$
NNFI	$0.97\leq NNFI\leq 1$	$0.95\leq NNFI\leq 0.97$
CFI	$0.97\leq CFI\leq 1$	$0.95\leq CFI\leq 0.97$
GFI	$0.95\leq GFI\leq 1$	$0.90\leq GFI\leq 0.95$
AGFI	$0.90\leq AGFI\leq 1$	$0.85\leq AGFI\leq 0.90$

RMSEA: Root mean square error of approximation, GFI: Goodness of fit index, CFI: Comparative fit index, AGFI: Adjusted goodness of fit index

found that none of the suggested modifications would improve the model fit critically. Especially, the suggested modifications did not improve the Chi-square value; hence, no modifications were made and the model was confirmed.

After analyzing the measurement model, the second-order CFA was conducted to discover the relationships between the latent structure of the scale. The six first-order factors determined via EFA and confirmed with CFA were grouped under three second-order factors: Mastery, Avoidance, and Approach as stated in the theories on the scale is based on. The model hypothesized six first-order factors (PGAvoid-Cognitive, MG-Affective, MG-Cognitive, PGAppr-Affective, PGAppr-Cognitive, and PGAvoid-Affective) and three second-order factors (Mastery, Performance-Approach, and Performance-Avoidance) of motivation. The Chi-square statistic was calculated as 654.54 and the ratio of the Chi-square value to the degrees of freedom (df = 161) was 4.08, showing a good level of model fit. The ρ-value of the hypothesized model was significant and the RMSEA was 0.072, indicating an acceptable level of modal fit. After the first examination of the model, the relationships between the factors and latent variables were analysed and the structural equation coefficients are given in Table 5.

In Table 5, the standardized coefficients between the first-and second-order latent variables are shown. For all the second-order factors, the covariates were high. Only the approach factor had weaker relationships with the related first-order factors. The ρ-value of the model was significant; hence the analyses continued with the examination of model fit statistics. The same statistics were examined with the first-order analyses and the results are given in Table 6.

According to the values given in Table 6, it can be concluded that the tested model had a moderate fit to the data. Nearly all the statistics were extremely close to the ones obtained from the first-order analyses. Lastly, the modification indexes were examined, and it was determined that no suitable modifications were needed, which may decrease the chi-square level of the analyses. Hence, no changes were made according to the modification suggestions and the modal was accepted as it was hypothesized according to the theories used in the scale development stage. The path diagram of the tested modal is given in Figure 3.

Table 4: The model-data fit indexes calculated for the tested model

Indexes	CFI	NFI	AGFI	IFI	GFI	SRMR	RMSEA	%90 C.I. RMSEA
Values	0.97	0.96	0.88	0.97	0.91	0.057	0.068	0.062; 0.074

Table 5: The standardized coefficients between the first and second-order latent variables

Latent variables	First-order					
Second order	**Factor 1**	**Factor 2**	**Factor 3**	**Factor 4**	**Factor 5**	**Factor 6**
Mastery		0.91			0.84	
Avoidance	0.91					0.89
Approach			0.64	0.79		

Table 6: The model-data fit indexes calculated for the second-order CFA model

Indexes	CFI	NFI	AGFI	IFI	GFI	SRMR	RMSEA	%90 C.I. RMSEA
Values	0.96	0.96	0.87	0.96	0.91	0.059	0.073	0.067; 0.079

CFA: Confirmatory factor analysis

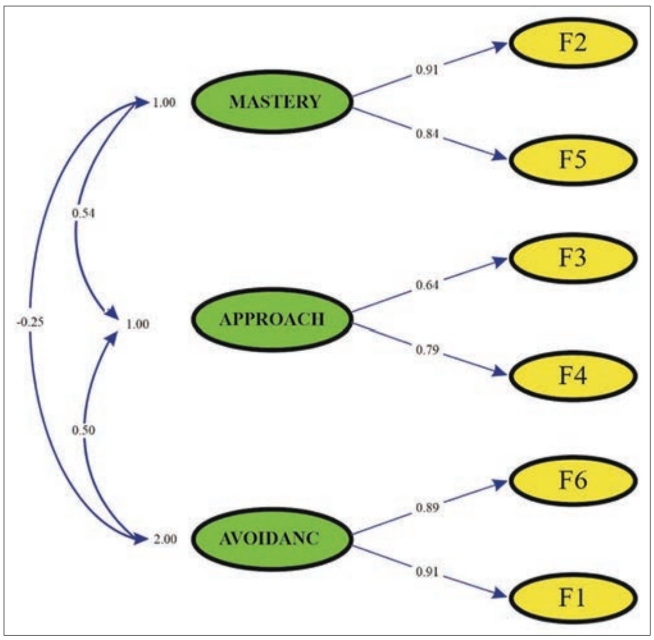

Figure 3: The path diagram of the second-order confirmatory factor analysis

Considering the results from the first-and second-order CFA, it was determined that theoretical structure has been validated for the developed scale in both the first-and second-order CFA tests. It is clear that the scale has acceptable construct validity in testing the goal orientations for learning biology in science teacher candidates.

Reliability

The internal consistency of the scale was analysed utilising Cronbach's alpha coefficients. Both the factor and scale level Cronbach alpha coefficients are presented in Table 7.

The Cronbach's alpha values of subscales ranged from 0.821 to 0.910, which indicated that the subscales were quite reliable. Furthermore, the item-total correlation coefficients were estimated higher than 0.40, which is the lower-bound value. Hence, it can be concluded that the items have high discrimination power and are consistent with the total scale.

Table 7: Cronbach alpha coefficients and descriptive statistics of items

Subscales	Items	X	SD	Item total correlation	Alpha
	1	4.019	0.946	0.815	
MG-Affective	3	3.936	1.004	0.787	0.910
	2	4.016	0.964	0.853	
	9	3.785	0.973	0.647	
	6	3.975	1.017	0.562	
MG-cognitive	11	3.921	0.906	0.648	0.851
	8	4.08	0.877	0.743	
	7	4.055	0.910	0.703	
	14	3.017	1.285	0.646	
PGAppr-affective	13	3.341	1.223	0.808	
	12	3.466	1.209	0.728	0.855
	16	3.803	1.138	0.654	
PGAppr-cognitive	17	3.833	1.077	0.715	0.823
	18	3.666	1.149	0.669	
	19	3.03	1.246	0.593	
PGAvoid-affective	20	2.793	1.365	0.757	0.824
	21	2.522	1.303	0.703	
	25	2.886	1.355	0.687	
PGAvoid-cognitive	24	3.097	1.412	0.795	0.821
	23	3.020	1.355	0.699	

DISCUSSION

This research provides the first implementation of cognitive-affective bifurcating to the mastery and performance (approach-avoidance) framework of goal orientation theory. Although there are some studies such as by Mascret et al.

(2017), and Yerdelen and Padır (2017) that have applied some variants of goal orientation to the teachers, the present study is the first research on the achievement goal orientation in biology learning with science teacher candidates. While most scales, which share homologous goal orientation frameworks, have been constructed in the context of pursuing general achievement goals, the present scale was constructed to determine the achievement goals orientation in the specific area of biology learning. The present research framework has six subscales, which are similar to the 3 × 2 model; however, in contrast to other variants of models in goal orientation theory, these items were constructed according to cognitive and affective distinction (Figure 1). When the scales of any other models (3 × 2 or 2 × 2) are reviewed, it can be seen that their items are constructed according to the distinction of "cognitive directed." The "cognitive directed" items address orientations based on one's beliefs and thoughts regarding achievement goals. It was determined in Boekaerts' study (1988) that students with approach rather than avoid learning tasks experienced predominantly negative feelings. In accordance with such feelings, students can adopt those goals, so as to avoid negative feelings. From this point of view, cognitive and affective bifurcating of the items compose the theoretical measurement model, which was confirmed by empirical data. The construct validity of the measurement model was tested using EFA and CFA. The results of EFA showed that the items cluster under six factors the observed data and the proposed measurement model have fitted, after the five items, which were loaded in more than one factor, were omitted. When reviewing these problematic items, it should be comprehended that five of them (2, 4, 5, 10, and 11) were cross loaded under mastery and performance goal factors, although these were operationalized in Mastery Goals. The first order CFA results show an acceptable fit, as evidenced by values of RMSEA, CFI, NFI, GFI, and AGFI. In CFA analysis procedures, second order CFA was conducted by doing the attainment of factors to variable to high level of latent variable. In the present study, the high level of latent variables were constructed as the base measurement model (Figure 1). In the base measurement model, there were three high level latent variables: Mastery Goals, Performance-Approach Goals, and Performance-Avoidance Goals. The second order CFA results also revealed an acceptable fit. In this regard, the construct validity of the measurement instrument was established. The reliability of the instrument was tested by calculating Cronbach's alpha and evaluating item-total correlation. These analyses revealed the internal consistency of the instrument and the high discrimination power of its items.

Although it is stressed that the goals direct the thoughts, behaviours, and emotions (Schutz et al., 2001; Çetin and Eren, 2019) it is rare to find research exploring the role of discrete achievement emotions in mediating achievement goals and student learning, particularly non-cognitive outcomes (Zhiqiang and Wenshu, 2022). In such rare research (e.g., Huang, 2011), learners' achievement goals and emotions naturally have been defined within different frameworks to determine the relationship between them. In the theoretical framework of achievement emotions, Pekrun et al. (2006) have incorporated enjoyment, hope, pride, boredom, anger, anxiety, hopelessness, and shame. In accordance with this structure, some studies provide empirical evidence that achievement emotions are effective on learning and academic performance in domains such as mathematics and science (Camacho-Morles et al., 2021; Putwain et al., 2021).

Ethics Statements

In the year the study was conducted, there was no ethical committee for educational study. Therefore, after the meeting of the approval of faculty administrations, the data collection from participants was conducted. The participants of the current study were adult university students and were elucidated regarding the framework of the study. At the end of the lecture sessions, the questionnaire forms were given to the voluntary participants for data collection.

CONCLUSION

The frame of the achievement goals construct contains no affective or emotional items with the exception of Elliot's works. (e.g., Elliott and Dweck, 1988; Elliot and Church, 1997; Elliot, 1999; Elliot and McGregor, 2001). Elliot and Church (1997) included items with affective character in the achievement goals questionnaire although in the theoretical framework of the questionnaire affective or emotional domain is not stressed. These emotions are hope, fear and anxiety, which are considered within the framework of achievement emotions by Pekrun et al. (2006). In contrast to this, the current study integrates such emotions (shame, fear, pride, and enjoyment) into the achievement goal orientation (see Appendix). In the current study, the items were constructed to the theoretical structure in the context of achievement goals. Affective-directed items, which state positive (enjoyment and pride) or negative affective (fear, shame) goals were established by showing a good model fit within the theoretical structure in relation to mastery and performance approach and -avoidance goals.

REFERENCES

Ames, C. (1992). Classrooms: Goals, structure, and student motivation. *Journal of Educational Psychology*, 84(3), 261-271.

Ames, C., & Archer, J. (1987). Mothers' belief about the role of ability and effort in school learning. *Journal of Educational Psychology*, 79, 409-414.

Atasoy, V. (2015). The role of achievement goal orientations and interest on metacognitive strategy use of pre-service science teachers. *Turkish Journal of Education*, 4(3), 4-15.

Atkinson, J.W. (1957). Motivational determinants of risk-taking behavior. *Psychological Review,* 6, 359-372.

Atkinson, J.W. (1964). *An Introduction to Motivation*. New York: Van Nostrand.

Atkinson, J.W. (1966). Motivational determinants of risk taking behavior. In: Atkinson, J.W., & Feather, N.T. (Eds.), *A Theory of Achievement Motivation*. United States: Wiley, pp. 11-31.

Aydin, S., Yerdelen, S., GürbüzoğLu Yalmanci, S., & Göksu, V. (2014). Academic motivation scale for learning biology: A scale development study. *TED Education and Science*, 39(176), 425-435.

Bahar, M., Johnstone, A.H., Hansell, M.H. (1999). Revisiting learning difficulties in biology. *Journal of Biological Education*, 33(2), 84-86.

Bandura, A. (1997). *Self-efficacy: The Exercise of Control*. New York: WH Freeman/Times Books/Henry Holt and Co.

Başer, M. (2007). *The Contribution of Learning Motivation, Reasoning Ability and Learning Orientation to Ninth Grade International Baccalaureate and National Program Students' Understanding of Mitosis and Meiosis*. Türkiye: Middle East Technical University.

Boekaerts, M. (1987). Individual differences in the appraisal of learning tasks: An integrative view on emotion and cognition. *Communication and Cognition*, 20(213), 207-224.

Boekaerts, M. (1988). Motivated learning: Bias in appraisals. *International Journal of Educational Research*, 12(3), 267-280.

Boekaerts, M. (1992). The adaptable learning process: Initiating and maintaining behavioural change. *Journal of Applied Psychology: An International Review*, 41(3), 377-397.

Boekaerts, M. (1996). Personality and the psychology of learning. *European Journal of Personality,* 10(5), 377-404.

Boekaerts, M. (2001). Context sensitivity: Activated motivational beliefs, current concerns and emotional arousal. In: Volet, S., & Järvelä, S. (Eds.), *Motivation in Learning Contexts: Theoretical Advances and Methodological Implications.* United Kingdom: Pergamon Press, pp. 1732.

Byrne, B.M. (2001). Structural equation modeling with AMOS, EQS, and LISREL: Comparative approaches to testing for the factorial validity of a measuring instrument. *International Journal of Testing*, 1(1), 55-86.

Camacho-Morles, J., Slemp, G.R., Pekrun, R., Lordered, K., Hou, H., & Oakes, L.G. (2021). Activity achievement emotions and academic performance: A meta-analysis. *Educational Psychology Review,* 33, 1051-1095.

Çetin, G., & Eren, A. (2019). Turkish prospective teachers' professional goals, beliefs about the attainability of these goals, identities, and possible selves. *Asia Pacific Education Review*, 20, 423-447.

Çimer, A. (2012). What makes biology learning difficult and effective: Students' views. *Educational Research and Reviews*, 7(3), 61-71.

Cook, D.A., Artino, A.R. (2016). Motivation to learn: An overview of contemporary theories. *Medical Education*, 50(10), 997-1014.

Costello, A.B. & Osborne, J. (2005). Best practices in exploratory factor analysis: four recommendations for getting the most from your analysis. *Practical Assessment, Research, and Evaluation*, 10(7), 1-9.

DeVellis, R.F. (2016). *Scale Development: Theory and Applications*. Vol. 26. United States: Sage Publications.

Dweck, C.S. (1986). Motivational process affects learning. *American Psychologist,* 41, 1040-1048.

Dweck, C.S., & Leggett, E.L. (1988). A social-cognitive approach to motivation and personality. *Psychological Review*, 95(2), 256-273.

Eccles, J.S., & Wigfield, A. (2002). Motivational beliefs, values, and goals. *Annual Review of Psychology*, 53(1), 109-132.

Eccles, J.S., & Wigfield, A. (2020). From expectancy-value theory to situated expectancy-value theory: A developmental, social cognitive, and sociocultural perspective on motivation. *Contemporary Educational Psychology*, 61, 101859.

Ekici, G. (2009). Biyoloji dersi motivasyon anketinin Türkçe 'ye uyarlanması [Adaptation of biology course motivation questionnaire to Turkish]. *Çağdaş Eğitim Dergisi* [*Journal of Contemporary Education*], 34(365), 6-15.

Elliot, A.J. (1999). Approach and avoidance motivation and achievement goals. *Educational Psychologist*, 34(3), 169-189.

Elliot, A.J., & Church, M.A. (1997). A hierarchical model of approach and avoidance achievement motivation. *Journal of Personality and Social Psychology*, 72(1), 218-232.

Elliot, A.J., & Harackiewicz, J.M. (1996). Approach and avoidance achievement goals and intrinsic motivation: A mediational analysis. *Journal of Personality and Social Psychology*, 70(3), 461-475.

Elliot, A.J., & McGregor, H.A. (2001). A 2*2 Achievement goal framework. *Journal of Personality and Social Psychology*, 80, 50-519.

Elliot, A.J., & Pekrun, R. (2007). Emotion in the hierarchical model of approach-avoidance achievement motivation. In: Schutz, P.A., & Pekrun, R. (Eds.), *Emotion in Education*. Cambridge, MA: Elsevier Academic, pp. 57-73.

Elliot, A.J., & Thrash, T.M. (2001). Achievement goals and the hierarchical model of achievement motivation. *Educational Psychology Review,* 13(2), 139-156.

Elliot, A.J., Murayama, K., & Pekrun, R. (2011). A 3 × 2 achievement goal model. *Journal of Educational Psychology*, 103(3), 632-648.

Elliott, E.S., & Dweck, C.S. (1988). Goals: An approach to motivation and achievement. *Journal of Personality and Social Psychology,* 54(1), 5-12.

Floyd, F.J., & Widaman, K.F. (1995). Factor analysis in the development and refinement of clinical assessment instruments. *Psychological Assessment*, 7(3), 286.

Fortus, D., & Vedder-Weiss, D. (2014). Measuring students' continuing motivation for science learning. *Journal of Research in Science Teaching*, 51(4), 497-522.

Glynn, S.M. & Koballa, T.R. (2006). Motivation to learn in college science. In: Mintzes, J., & Leonard, W.H. (Eds.), *Handbook of College Science Teaching*. Virginia: National Science Teachers Association Press, pp. 25-32.

Glynn, S.M., Taasoobshirazi, G., & Brickman, P. (2009). Science motivation questionnaire: Construct validation with non-science majors. *Journal of Research in Science Teaching*, 46(2), 127-146.

Hair, J.F., Black, W.C., Babin, B.J., Anderson, R.E., & Tatham, R. (2010). *Multivariate Data Analysis*. 7th ed. United States: Prentice Hall.

Hayat, A.A., Shateri, K., Amini, M., & Shokrpour, N. (2020). Relationships between academic self-efficacy, learning-related emotions, and metacognitive learning strategies with academic performance in medical students: A structural equation model. *BMC Medical Education*, 20(1), 76.

Huang, C. (2011). Achievement goals and achievement emotions: A meta-analysis. *Educational Psychology Review*, 23, 359.

Jöroskog, K.G., Sörbom, D. (1993). *LISREL 8: Structural Equation Modeling with SIMPLIS Command Language*. United States: Scientific Software International.

Józsa, K., & Barrett, K.C. (2018). Affective and social mastery motivation in preschool as predictors of early school success: A longitudinal study. *Early Childhood Research Quarterly*, 45(4), 81-92.

Kaiser, H.F. (1974). An index of factorial simplicity. *Psychometrika*, 39(1), 31-36.

Kışoğlu, M. (2018). An examination of science high school students' motivation towards learning biology and their attitude towards biology lessons. *International Journal of Higher Education*, 7(1), 151-164.

Kline, R.B. (2011). *Principles and Practice of Structural Equation Modeling*. 5th ed. New York City: Guilford Press, pp. 3-427.

Lee, O., & Brophy, J. (1996). Motivational patterns observed in sixth-grade science classrooms. *Journal of Research in Science Teaching*, 33(3), 585-610.

Lee, S.Y (2007). *Structural Equation Modelling: A Bayesian Approach*. United States: John Wiley and Sons, Ltd.

Lewin, K., Dembo, T., Festinger, L., & Sears, P.S. (1944). Level of aspiration. In: McHunt, J. (Ed.), *Personality and the Behavior Disorders*. Vol. 1. New York: Ronald Press, pp. 333-378.

Lin, T.J., & Tsai, C.C. (2017). Developing instruments concerning scientific epistemic beliefs and goal orientations in learning science: A validation study. *International Journal of Science Education*, 39(17), 2382-2401.

Maehr, M.L., & Nicholls, J.G. (1980). Culture and achievement motivation: A second look. In: Warren, N. (Ed.), *Studies in Cross-Cultural Psychology*. Vol. 3. United States: Academic Press, pp. 221-267.

Mascret, N., Elliot, A.J., & Cury, F. (2017). The 3 × 2 achievement goal questionnaire for teachers. *Educational Psychology*, 37(3), 346-361.

McClelland, D.C. (1951). Measuring motivation in phantasy: The achievement motive. In: Guetzkow, H. (Ed.), *Groups, Leadership, and Men*. United States: Carnegie Press, pp. 191-205.

Mega, C., Ronconi, L., & De Beni, R. (2014). What makes a good student? How emotions, self-regulated learning, and motivation contribute to academic achievement. *Journal of Educational Psychology*, 106(1), 121-131.

Netemeyer, R.G., Bearden, W.O., & Sharma, S. (2003). *Scaling Procedures: Issues and Applications*. United States: Sage Publications.

Pajares, F. (1996). Self-efficacy beliefs in academic settings. *Review of Educational Research*, 66(4), 543-578.

Pekrun, R. & Stephens, E.J. (2010). Achievement emotions in higher education. In: Smart, J.C. (Ed.), *Higher Education: Handbook of Theory and Research*. Gemany: Springer, pp. 257-306.

Pekrun, R. (2019). Inquiry on emotions in higher education: progress and open problems. *Studies in Higher Education*, 44(10), 1806-1811.

Pekrun, R., Elliot, A.J., & Maier, M.A. (2006). Achievement goals and discrete achievement emotions: A theoretical model and prospective test. *Journal of Educational Psychology*, 98, 583-597.

Pekrun, R., Goetz, T., Titz, W., & Perry, R.P. (2002). Academic emotions in students' self-regulated learning and achievement: A program of qualitative and quantitative research. *Educational Psychologist*, 37(2), 91-105.

Pekrun, R., Lichtenfeld, S., Marsh, H.W., Murayama, K., & Goetz, T. (2017). Achievement emotions and academic performance: Longitudinal models of reciprocal effects. *Child Development,* 88(5), 1653-1670.

Pintrich, P.R. (2000a). Multiple goals, multiple pathways: The role of goal orientation in learning and achievement. *Journal of Educational Psychology*, 92(3), 544-555.

Pintrich, P.R. (2000b). The role of goal orientation in self-regulated learning. In: Boekaerts, M., Pintrich, P.R., & Zeidner, M. (Eds.), *Handbook of Self-regulation: Theory, Research, and Applications*. United States: Academic Press, pp. 451-502.

Pintrich, P.R., & Groot, E.V.D. (1990). Motivational and self-regulated learning components of classroom academic performance. *Journal of Educational Psychology, 82*(1), 33-40.

Pintrich, P.R., Marx, R.W., & Boyle, R.A. (1993). Beyond cold conceptual change: The role of motivational beliefs and classroom contextual factors in the process of conceptual change. *Review of Educational Research*, 63(2), 167-199.

Putwain, D.W., Schmitz, E.A., Wood, P., & Pekrun, R. (2021). The role of achievement emotions in primary school mathematics: Control-value antecedents and achievement outcomes. *British Journal of Educational Psychology*, 91(1), 347-367.

Schermelleh-Engel, K., Moosbrugger, H., & Müler, H. (2003). Evaluating the fit of structural equation models: Tests of significance and descriptive goodness-of-fit measures. *Methods of Psychological Research Online,* 8(2), 23-74.

Schunk, D.H., & Pajares, F. (2001). The development of academic self-efficacy. In: Wigfield, A., Eccles, J. (Eds.), *Development of Achievement Motivation*. United States: American Press, pp. 15-31.

Schunk, D.H., Meece, J., & Pintrich, P.R. (2014). *Motivation in Education Theory, Research, and Applications*. 4th ed. United Kingdom: Pearson.

Schutz, P.A., Crowder, K.C., & White, V.E. (2001). The development of a goal to become a teacher. *Journal of Educational Psychology*, 93(2), 299-308.

Shihusa, H., & Keraro, F.N. (2009). Using advance organizers to enhance students' motivation in learning biology. *Eurasia Journal of Mathematics, Science and Technology Education*, 5(4), 413-420.

Sümer, N. (2000). Yapısal eşitlik modelleri: Temel kavramlar ve örnek uygulamalar [Structural equation models: Basic concepts and sample applications]. *Türk Psikoloji Yazıları [Turkish Psychology Writings]*, 3(6), 49-74.

Tabachnick, B.G., & Fidell, L.S. (2007). *Experimental Designs Using ANOVA*. California, United States: Thomson/Brooks/Cole.

Tabachnick, B.G., & Fidell, L.S. (2014). *Using Multivariate Statistics*. (Pearson New International Edition). 6th ed. United Kingdom: Pearson.

Thompson, B. (2004). *Exploratory and Confirmatory Factor Analysis: Understanding Concepts and Applications*. 1st ed. United Kingdom: Psychology Press.

Tuan, H., Chin, C., & Shieh, S. (2005). The development of a questionnaire to measure students' motivation towards science learning. *International Journal of Science Education*, 27(6), 639-654.

Urdan, T., & Kaplan, A. (2020). The origins, evolution, and future directions of achievement goal theory. *Contemporary Educational Psychology*, 61, 101862.

Velayutham, S., Aldridge, J., & Fraser, B. (2011). Development and validation of an instrument to measure students' motivation and self-regulation in science learning. *International Journal of Science Education*, 33(15), 2159-2179.

Volet, S.E. (1997). Cognitive and affective variables in academic learning: The significance of direction and effort in students' goals. *Learning and Instruction*, 7(3), 235-254.

Wigfield, A., & Eccles, J.S. (1992). The development of achievement task values: A theoretical analysis. *Developmental Review*, 12(3), 265-310.

Wigfield, A., Tonks, S., & Suzan, K.L. (2009). Expectancy-value theory. In: Wentzel, K.R., & Wigfield, A., (Eds.), *Handbook of Motivation at School*. United Kingdom: Routledge, pp. 57-75.

Wilde, M., Hußmann, J.S., Lorenzen, S., Meyer, A., & Randler, C. (2012). Lessons with Living Harvest Mice: An empirical study of their effects on intrinsic motivation and knowledge acquisition. *International Journal of Science Education*, 34(18), 2797-2810.

Wolters, C.A., & Rosenthal, H. (2000). The relation between students' motivational beliefs and their use of motivational regulation strategies. *International Journal of Educational Research*, 33, 801-820.

Worthington, R.L., & Whittaker, T.A. (2006). Scale development research: A content analysis and recommendations for best practices. *The Counseling Psychologist*, 34(6), 806-838.

Yerdelen, S., & Padır, M.A. (2017). Öğretmenler için 3x2 başarı yönelimi ölçeğinin Türkçe'ye uyarlanması: Geçerlilik-güvenirlik çalışması. [Turkish adaptation of the 3x2 achievement orientation scale for teachers: A validity-reliability study] *Bartın Üniversitesi Eğitim Fakültesi Dergisi* [*Bartın University Journal of the Faculty of Education*], 1053-1065.

Yerdelen, S., Aydin, S., Yalmanci, S.G., & Göksu, V. (2014). Relationship between high school students' achievement goal orientation and academic motivation for learning biology: A path analysis. *TED Education and Science*, 39(176), 437-446.

You, H.S., Kim, K., Black, K., & Min, K.W. (2018). Assessing science motivation for college students: validation of the science motivation questionnaire II using the Rasch-Andrich rating scale model. *Eurasia Journal of Mathematics, Science and Technology Education*, 14(4), 1161-1173.

Zhiqiang, L. & Wenshu, L. (2022). Discrete achievement emotions as mediators between achievement goals and academic engagement of Singapore students, *Educational Psychology*, 42(6), 746-766.

APPENDIX

English translation of the Turkish version of the Achievement Goal Questionnaire for Biology Learning (AGQ-BL)

The following expressions describe types of goals that you may or may not have when you learn biology. For every item, thick a mark on the scale from 1 (strongly disagree) to 5 (strongly agree) to express your grade of acceptance with the statement.

I study biology…

F2: Mastery Goals Items –Affective directed (MG-Affective)

1. … since it's enjoyable to insight subject matter in daily life context.
3. … since I enjoy learning about the mechanism that rules the world of living things.
2. … since I enjoy being knowledgeable about novel things.

F-5: Mastery Goals Items-Cognitive directed (MG-Cognitive)

9. … to understand the system that rules the universe.
6. … to solve problems related to my health if I have health problems.
11. … to contribute to solving the environmental issues.
8. … to live consciously and healthy.
7. … to learn the mechanism that rules the world of living things

F3: Performance-Approach Goals Items-Affective directed (PGAppr-Affective)

14. … since I care that they think I'm the best in my study area.
13. … since I feel proud to obtain the best exam point.
12. … since I enjoy knowing subjects better than anyone else.

F4: Performance-Approach Goals Items-Cognitive directed (PGAppr-Cognitive)

16. … to get better performance than my competitors in an exam for being a staffed teacher.
17. … in order to graduate from university in the best way.
18. … to get the best grade from the course.

F6: Performance –Avoidance Goals Items-Affective directed (PGAvoid-Affective)

19…. to avoid being unsuccessful so that I avoid feeling bad.
20. … to avoid being a failure so that I escape being shamed about it.
21. … to avoid fear about appraisals as lazy.

F1: Performance-Avoidance Goals Items-Cognitive directed (PGAvoid-Cognitive),

25. … to avoid getting worse grades than my classmates.
24. …to avoid delay in my graduation.
23. … to avoid failing the course.