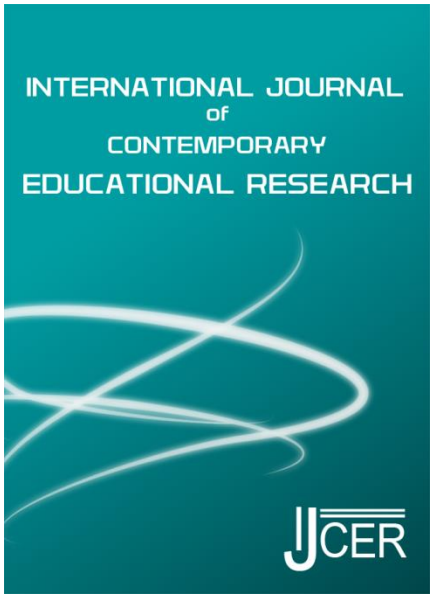

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A Scale Development Study to Determine Disciplined Mind Features of 4th Grade Students

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Abstract

The aim of this study is to develop a Disciplined Mind Scale (DMS) in order to determine the disciplined mind features of 4th grade students. Considering that students around the age of 11 can have some scientific thinking skills, it is thought that the disciplined mind features of 4th grade students should be determined. The sample of this research, in which the survey method was used, consists of 400 students studying in Afyonkarahisar-Turkey, in the 2018-2019 academic year. 23 items were removed from the item pool consisting of 50 items and a final form of 27 items, 7 negative and 20 positive, was obtained. KMO (Kaiser-Meyer Olkin) value was calculated as .862 and Cronbach alpha value as .826. As a result of the factor analysis, it was seen that the factor loading values of the items were between .426 and .786. It was determined that the scale consists of 5 factors (thinking like a scientist, making interdisciplinary connections, motivation to live with discipline, deep learning, connection with daily life). As a result of validity and reliability analyzes, it was seen that it can be accepted as a valid and reliable measurement tool consisting of 5 sub-dimensions that measures disciplined mind traits of 4th grade students.

Key words: Five minds, Disciplined mind, Disciplined mind scale.

Introduction

Just as in the past, learning is of great importance today. Learning is a need that exists in the creation of the individual. In the world of the 21st century, there have been some changes in the expectations of the society from individuals, as well as changes and developments in learning needs and teaching styles. Individuals are expected not only to have knowledge, but also to be able to use their knowledge skillfully and adapt it to new situations. The globalizing world order expects individuals to have creativity and innovation skills.

Individuals will be expected to develop some types of mind in the future (Nofsinger & Young, 2010). These mind types are "disciplined mind", "synthesizing mind", "creative mind", "respectful mind" and "ethical mind" (Gardner, 2006). Three of these mind types, called five mind types, consist of cognitive mind types, and the remaining two are relational mind types (Stork, Wodilla, Brown, Ogilvie, Rutter & Trefry, 2010). Individuals who can only have five mind types will be able to produce unique products. Educators will aim to develop five minds in individuals. When the characteristics of the type of individual that educators want to train in the future with the five mind areas put forward; It envisages a human model that has disciplined thinking skills, has been able to develop the synthesizing mind structure and thus acquires creative thinking skills, can demonstrate the skills to respect the rules of ethics and ethical principles while exhibiting these skills, and that can be beneficial to the society, the environment and the world. It is stated that it is of great importance to develop a disciplined mind in order to develop the synthesizing mind and creative mind features in the five mind areas (Gardner, 2006).

Disciplined mind means having a mind developed specific to the discipline. One of the main goals in the disciplined mind is that individuals are mastered in at least one discipline (Chang & Lee, 2008). This discipline can be a branch of art, profession, history or sociology from the humanities. In one discipline, the process of qualification can take up to ten years (Stork et al, 2010). It is thought that developments such as Newton's

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disclosure of the law of gravity and Wilhelm C. Röntgen's finding of x-rays, which have a great importance in our lives, did not come into existence all of a sudden.

The disciplined mind begins only during adolescence and continues for the rest of a person's life (Pava, 2008). Therefore, it is thought that the disciplined mental characteristics of the students should be developed starting from the primary school period. Gardner states that although he studied psychology, it took him ten years to learn to think like a psychologist. Several years of intense engagement with the subject area are required to internalize a thinking style. Disciplined mind refers to the ability to adopt an academic discipline's thinking style (Schneider, 2014). Considering that the process of competence in a discipline can last up to ten years, the importance of developing a disciplined mind from primary school becomes apparent. All professional groups, whether they are lawyers or engineers, should have the basic principles and knowledge of their profession enough to deserve to be a member of their profession. An individual with a disciplined mind should have the ability to think specific to his profession (Sawyer, 2008).

It is believed that the five minds must be developed for the future (Nofsinger & Young, 2010). It is thought that learners with a disciplined mind will thus become lifelong learners. Individuals who cannot master one or more disciplines will not be able to succeed in any challenging workplace and will be limited to mundane tasks that are not of great importance (Chang & Lee, 2008). Who believes that current formal education prepares students for the possible worlds of the future, but primarily for the past world (Essig, 2012), education for five minds is challenging in all contexts. Developing a disciplined mind requires constant effort over a long period of time. In a context in which test scores guide more and more educational decisions, it is questionable whether training is possible for five minds (Davis & Gardner, 2012).

The aim of this research is to develop a Disciplined Mind Scale (DMS) to examine the disciplined mind features of 4th grade students. It is stated that children around the age of 11 have scientific thinking skills such as observing facts, recording data, and determining the effects of independent variables on dependent variables (Keys & Bryan, 2001). It is thought that it is important to examine disciplined mind features, since the 4th grade students, which constitute the universe of the study, are also in the 10-11 age group. It is stated that it may take approximately ten years to specialize in one or more disciplines. Individuals who specialize in disciplines will be the wanted individuals of the future (Gardner, 2006). Individuals with a disciplined mind are those who use and master "major scientific disciplines and ways of thinking about major professions" (Pava, 2008).

In primary schools in Turkey, the students are gaining 1st grade reading and writing skills. In addition, it is aimed to gain listening and speaking skills (Turkish Republic Ministry of Education, 2017). In Turkey, Mathematics and Turkish courses are started in the 1st grade primary school and continues throughout the primary school. Science course starts in the 3rd grade of primary school. It is thought that students need some pre-learning and positive attitude about these disciplines in order to teach disciplines in the secondary school and high school period.

As a result of the literature review, it was observed that five themes related to disciplined mind were formed (Can Aran, 2014). These themes appear as thinking like a scientist, making interdisciplinary connections, motivating to live with discipline, learning in depth, and connecting with daily life.

"Thinking like a scientist" enables students to focus on real-world issues that they find relevant to their own lives (Williams, Papierno, Makel & Ceci, 2004). The scientist must have an enlightened personality with a universal thinking structure (Ortaş, 2004). Scientists should be curious, open-minded, free, resourceful, and have the ability to communicate effectively (Jarrard, 2001). Scientists should not hesitate to reveal the facts and should have high character (Yıldırım, 2006). Scientists often try to explore their surroundings by asking the question of why (Chiappetta & Koballa, 2006) and they are people who research what is, not what should be (Abruscato, 2000). With the education program "Thinking Like a Scientist" developed by the Cornell Children's Research Institute (CIRC), it is aimed to reach students with innovative materials that train thinking and reasoning in scientific method about the problems in daily life (Williams, Papierno, Makel & Ceci, 2004). Science is a human activity and it is important to give students a comprehensive view of the nature of science (Bybee, 2006).

"Interdisciplinary connection" is the holistic approach of a concept, theme or problem using the method and language of more than one discipline (Jacobs, 1989; Erickson, 1995). According to the concept of interdisciplinary connection, disciplines are interconnected and real life problems do not always have one true (Perkins, 1994). By establishing interdisciplinary connections, it is possible to view information from different

angles (Şahbaz & Çekici, 2012). In order to achieve permanent learning, a connection must be established between the learned information (Bruner, 1999).

A student who is "motivated to live with discipline" will not need external reinforcements thanks to the pleasure of internal motivation (Kelecioğlu, 1992). Motivation is an inner force that drives the individual. If students find the information they learn meaningful and worth learning, it will enable them to be motivated against learning (Chiappetta & Koballa, 2006).

There are internal movements in the process of "deep learning". The process of students searching for meaning between concepts or disciplines and creating a meaningful link occurs (Ekinci, 2009). A student who strives for in-depth learning creates a purposeful and orderly study order by truly engaging with the subject area. He tends to investigate the reasons behind what is presented to him (Biggs & Kirby, 1983).

As individuals can find the opportunity to make connections between what is learned through daily life, permanent learning will take place (Bruner, 1999), individuals' preparation for life and being able to attribute meaning to the events in their daily lives are among the main objectives of education (Coştu, Ünal, & Ayas, 2007). Considering that students may have difficulties in determining how to relate what they learn in school and classroom environment in daily life (Doruk & Umay, 2010), purposeful teaching environments that can guide the use of what is learned in daily life should be designed instead of a random design in the arrangement of learning environments (Dewey, 2010).

Method

Research Design

In this study, survey method was used, which aims to describe the views and characteristics of large masses (Büyüköztürk, 2015) and can be generalized towards the represented universe in line with the data obtained from the sample (Cohen, Manion, & Morrison, 2007; Özdemir, 2015). Research data were collected from 4th grade students through a questionnaire.

Population and Sample

The population of the study consists of 4558 4th grade students studying in the 2018-2019 academic year. The sample of the study consists of 400 students, 207 male (%) and 193 female (%) students attending 4th grade. Simple random sampling technique was used in the study. It is assumed that the number of participants can represent the universe (Büyüköztürk, 2015; Çıngı, 1994).

Item Pool Phase

In this study, first of all, the relevant literature was researched and disciplined mind features were examined under 5 themes (Can Aran, 2014). Open-ended questions were created according to the determined themes and expert opinion was sought. Then, a form consisting of open-ended questions was distributed to 138 4th grade students and they were asked to answer in writing in the classroom. In the light of the answers obtained, a trial form consisting of 50 items was obtained by referring to the opinions of two experts who are faculty members in the field of Curriculum and Instruction and an expert who is a faculty member in the field of Science Education.

Statistics

Following the creation of the item pool, the trial form was administered to 400 students attending 4th grade. By applying KMO test and Bartlett's test of sphericity on the obtained data, the suitability of the data to the exploratory factor analysis was determined.

KMO and Barlett test values were examined in order to determine the suitability of the data obtained from the DMS trial form to exploratory factor analysis. A new structure can be revealed by questioning the relationships between variables with the exploratory factor analysis (Can, 2017). According to the result of exploratory factor analysis conducted to examine the construct validity, the KMO (Kaiser Meyer Olkin) test value calculated as .84 shows that the sample size is sufficient. The value of .000 found as a result of Barlett's test of sphericity shows that the data meet the multiple normality assumption ($p < .01$). The fact that the KMO coefficient is greater than .60 and the result of the Barlett test is significant indicates that the data set is suitable for principal component

analysis and is sufficient in terms of sample size (Can, 2017). In this case, it was concluded that the data obtained from the trial application of the scale was suitable for factor analysis.

Factor analysis is a statistical technique that aims to explain the measurement of variables that measure the same structure or quality by collecting them together with a small number of factors (Büyüköztürk, 2011). The factor loads of the items in the DMS were calculated, and the factors under which the items were found were determined with the transformed components matrix. In order to examine validity in item analysis, the mean scores of the end groups were compared using the t test. In order to determine whether there is a significant relationship between the dimensions of the DMS, Pearson correlation analysis has been performed. Confirmatory factor analysis was conducted to test the compatibility of the 5-factor scale, which was formed as a result of the exploratory factor analysis, with the model. Confirmatory factor analysis is a type of factor analysis that tests specific hypotheses about the structure and relationships between hidden variables underlying the data (Field, 2013). The reliability of the resulting factors was analyzed by calculating Cronbach's Alpha values. Alpha coefficient, which is also accepted as the lowest limit of the reliability coefficient, can be accepted as an internal consistency index (Tekindal, 2015).

As a result of the analyzes performed on the trial form, which initially consisted of 50 items, 23 items were removed from the scale. The analyzes made in the development of the Disciplined Mind Scale are given below.

Results

Exploratory Factor Analysis

By starting the analysis of the scale consisting of 50 items with factor analysis, a total of 14 factors were obtained at the first stage, and it was determined that the 14 factors that were obtained explain 56% of the total variance. As a result of the factor analysis, 23 items were removed from the scale. During factor analysis, items no 2, 25, 8, 7, 22, 38, 9, 45, 40, 33, 21, 32, 30, 35, 36, 13, 27, 20, 46, 34, 37, 42, 48 were Since it was seen that the difference between matrix values was less than .10, they were excluded from the scale. The common variance value explained by each item must be at least .10 (Seçer, 2015). However, due to the large number of factors, a line chart was used to determine the actual number of factors. One of the two statistical techniques generally used in determining the number of factors is eigenvalue plot and the other is scree plot (Salkind ve Green, 2005). In order to determine the number of factors, it was observed that there were 5 main break points in the line graph and the slope started to disappear after these break points. The number of components indicated by the point where the slope starts to disappear in the graph is taken as the number of factors to be calculated. The interval between two points on the line chart indicates a factor. During factor analysis, it can be said that it would be a much more accurate approach to consider more than one technique together instead of using a single technique during the factor determination or factor number decision (Seçer, 2015). Based on the main breaking points, the scale is limited to 5 factors.

The KMO value obtained as a result of factor analysis has increased to .862, and 5 factors explain 47.99% of the total variance. Items with a KMO value of .862 and an initial eigenvalue greater than 1.00 were included in the scale. The values obtained can be accepted as an indicator that factor analysis can be applied (Cureton and D'Agostino, 1983). The variance values explained for the total factor analysis of the disciplined mind scale are given in Table 1.

Table 1. Total Variance Explained Table of DMS

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.72	21.186	21.186	5.72	21.186	21.186	3.135	11.61	11.61
2	3.07	11.372	32.557	3.07	11.372	32.557	2.98	11.036	22.647
3	1.677	6.212	38.769	1.677	6.212	38.769	2.609	9.663	32.31
4	1.352	5.009	43.778	1.352	5.009	43.778	2.39	8.851	41.161
5	1.139	4.217	47.995	1.139	4.217	47.995	1.845	6.834	47.995

As seen in Table 1, it is seen that a structure with 5 factors has been formed. According to Seçer (2015), the concept of eigenvalue in factor analysis is a condition that shows the variance explained by a factor alone, and in factor analysis, the eigenvalue of a sub-dimension is expected to be at least 1. In addition, each of the sub-factors is expected to explain at least 5% of the total variance in the scale. In this sense, when determining the number of factors in a scale, dimensions with an eigenvalue above 1 and the variance value explained above 5% should be determined as sub-dimensions. According to Tekindal (2015), it is not appropriate to make a decision about the items just by looking at the common variance. It is desirable that the variance explained should be high. It is desirable to achieve the highest variance with the least factor. In social sciences, variances explained between 45 and 60 are generally encountered. It is seen that the obtained scale explains the total variance rate by 47.99%, the lowest sub-dimension eigenvalue is 1.84 and the sub-factors explain the total variance at the lowest 6.83%.
As a result of the evaluation made by considering all the criteria, 23 items of the 50-item trial scale were removed from the scale, and in this case, 27 items remained in the scale, 7 of which were negative and 20 of which were positive.

The factors under which the items belonging to the Disciplined Mind Scale are collected and the factor loads of the items are given in Table 2.

Table 2. Rotated Component Matrix[a]

	Component				
DMS	1	2	3	4	5
Factor 1. Thinking like a scientist (α=.767)					
DMS_8	.661				
DMS_13	.653				
DMS_12	.638				
DMS_16	.625				
DMS_3	.608				
DMS_6	.546				
DMS_9	.426				
Factor 2. Interdisciplinary connection (α=.769)					
DMS_22		.746			
DMS_21		.736			
DMS_26		.713			
DMS_18		.650			
DMS_15		.584			
DMS_23		.559			
DMS_25		.457			
Factor 3. Motivation to live with discipline (α=.708)					
DMS_4			.671		
DMS_11			.597		
DMS_14			.595		
DMS_5			.589		
DMS_2			.584		
Factor 4. Deep learning (α=.734)					
DMS_7				.709	
DMS_10				.684	
DMS_1				.576	
DMS_17				.565	
DMS_19				.532	
Factor 5. Connection with Daily life (α=.565)					
DMS_24					.786
DMS_27					.700
DMS_20					.536

As seen in Table 2, as a result of the analysis, it is seen that the factor load values for all five factors vary between .426 and .786. 7 items in the 1st factor (Thinking like a scientist), 7 items on the 2nd factor (Interdisciplinary connection), 5 items on the 3rd factor (Motivation to live with discipline), 5 items on the 4th factor (Deep learning), and the 5th factor (Connection with daily life). establishment) It has been determined that there are 3 items.

Another internal criterion of examining validity in item analysis is the comparison of the mean scores of the end groups (higher group-lower group) at the item level (Can, 2017). Accordingly, the answers given by the 27%

upper group and 27% sub group (108 people with the highest and lowest scores) were compared with the unrelated t test. The results of the t test made are given in Table 3.

Table 3. Comparison of Responses Given on Final Form in terms of Upper Group-Subgroup

Item Number	Groups	N	X	sd	t	p
DMS_1	Higher Group	108	3.40	1.223	-8.478	.00
	Lower Group	108	4.58	.762		
DMS_2	Higher Group	108	4.08	.892	-9.065	.00
	Lower Group	108	4.90	.321		
DMS_3	Higher Group	108	3.71	1.051	-8.642	.00
	Lower Group	108	4.68	.505		
DMS_4	Higher Group	108	3.83	1.195	-8.666	.00
	Lower Group	108	4.87	.379		
DMS_5	Higher Group	108	4.24	.935	-7.125	.00
	Lower Group	108	4.91	.309		
DMS_6	Higher Group	108	3.49	1.264	-9.299	.00
	Lower Group	108	4.72	.544		
DMS_7	Higher Group	108	2.93	1.331	-8.888	.00
	Lower Group	108	4.30	.901		
DMS_8	Higher Group	108	3.13	1.370	-11.401	.00
	Lower Group	108	4.76	.573		
DMS_9	Higher Group	108	3.14	1.398	-8.282	.00
	Lower Group	108	4.49	.942		
DMS_10	Higher Group	108	2.92	1.418	-7.553	.00
	Lower Group	108	4.21	1.059		
DMS_11	Higher Group	108	4.00	1.10199	-8.597	.00
	Lower Group	108	4.94	.26768		
DMS_12	Higher Group	108	3.34	1.161	-10.967	.00
	Lower Group	108	4.71	.580		
DMS_13	Higher Group	108	3.15	1.382	-11.511	.00
	Lower Group	108	4.77	.479		
DMS_14	Higher Group	108	3.91	1.184	-8.954	.00
	Lower Group	108	4.95	.211		
DMS_15	Higher Group	108	3.48	1.562	-9.018	.00
	Lower Group	108	4.90	.503		
DMS_16	Higher Group	108	3.48	1.392	-10.333	.00
	Lower Group	108	4.90	.321		
DMS_17	Higher Group	108	3.09	1.226	-10.298	.00
	Lower Group	108	4.51	.754		
DMS_18	Higher Group	108	2.84	1.511	-6.339	.00
	Lower Group	108	4.09	1.384		
DMS_19	Higher Group	108	3.05	1.205	-9.882	.00
	Lower Group	108	4.41	.774		
DMS_20	Higher Group	108	3.89	1.400	-6.230	.00
	Lower Group	108	4.81	.613		
DMS_21	Higher Group	108	2.87	1.512	-10.283	.00
	Lower Group	108	4.61	.884		
DMS_22	Higher Group	108	2.36	1.342	-9.932	.00
	Lower Group	108	4.16	1.329		
DMS_23	Higher Group	108	3.30	1.475	-9.571	.00
	Lower Group	108	4.81	.712		
DMS_24	Higher Group	108	4.31	1.007	-5.305	.00
	Lower Group	108	4.90	.572		
DMS_25	Higher Group	108	2.23	1.287	-8.447	.00
	Lower Group	108	3.83	1.481		
DMS_26	Higher Group	108	2.60	1.459	-11.102	.00
	Lower Group	108	4.58	1.144		
DMS_27	Higher Group	108	4.30	1.155	-6.037	.00
	Lower Group	108	4.98	.135		

According to Table 3, as a result of the comparison made, it was determined that the difference between lower group and higher group of the items to be included in the final scale was significant.

As a result of the analyzes made, it was thought that the scale had five factors, and this situation reflected five basic structures (thinking like a scientist, interdisciplinary connection, motivation to live in discipline, deep learning, connecting with daily life). The results of the Pearson correlation analysis made to determine whether there is a relationship between the factors are given in Table 4.

Table 4. Relationship Between Factors

	N	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	X	SD
Factor 1	400	-	.138**	.533**	.545**	.279**	4.0853	.73594
Factor 2	400	.138**	-	.168**	.005	.235**	3.5529	1.00611
Factor 3	400	.533**	.168**	-	.415**	.397**	4.5315	.56029
Factor 4	400	.545**	.005	.415**	-	.200**	3.7453	.85455
Factor 5	400	.279*	.235**	.397**	.200**	-	4.6529	.62090

(**p<.01)

According to Table 4, as a result of the Pearson correlation analysis performed to determine whether there is a significant relationship between the DMS dimensions, it was found that there is a statistically positive significant relationship between them at .01 significance level. The highest positive relationship is between the 1st factor and the 4th factor (r = .545 **, p<.01), the lowest positive relationship is between the 1st factor and the 2nd factor (r = .138 **, p< .01).

Confirmatory Factor Analysis

Confirmatory factor analysis was conducted to test the compatibility of the 5-factor scale, which was formed as a result of the exploratory factor analysis, to the model. After the analysis, the program suggested a modification between 6 items in order to have a significant decrease in the Chi-square value and a better level of fit indices. Modifications were made between items numbered "11 to 15", "17 to 4", "18 to 12", "24 to 10", "28 to 23" and "50 to 44". After the modification, the fit indices were analyzed and it was found that the fit indices were acceptable and some were at excellent levels. Confirmatory factor analysis data of DMS are given in Table 5.

Table 5. Acceptable Fit Indexes and Values Found

Fit Index	Acceptable Values	Found Value
χ^2 / sd	$0 \leq \chi^2/sd \leq 2$ perfect fit	1.38
	$2 < \chi^2/sd \leq 3$ acceptable fit	
GFI	$.90 \leq GFI \leq 1.00$ perfect fit	0.93
	$.85 \leq GFI < .90$ acceptable fit	
AGFI	$.90 \leq AGFI \leq 1.00$ perfect fit	0.91
	$.85 \leq AGFI < .90$ acceptable fit	
NFI	$.95 \leq NFI \leq 1.00$ perfect fit	0.93
	$.90 \leq NFI < .95$ acceptable fit	
	$.97 \leq NFI \leq 1.00$ perfect fit	0.98
NNFI	$.95 \leq NFI < .97$ acceptable fit	
	$.97 \leq CFI \leq 1.00$ perfect fit	0.98
CFI	$.95 \leq CFI < .97$ acceptable fit	
	$0 \leq RMSEA \leq .05$ perfect fit	0.031
RMSEA	$.05 < RMSEA \leq .08$ acceptable fit	
	$0 \leq RMR \leq .05$ perfect fit	0.06
RMR	$.05 < RMR \leq .08$ acceptable fit	
IFI	$0.95 \leq IFI \leq 1.00$ perfect fit	0.98
	$0.90 \leq IFI < 0.95$ acceptable fit	

GFI: Goodness of Fit Index, **AGFI:** Adjusted Goodness Fit Index, **NFI:** Normed Fit Index, **NNFI:** Unscaled Fit Index, **CFI:** Comparative Fit Index, **RMSEA:** Root Mean Square Error of Approximation, **RMR:** Root Residual Mean of Squares, **IFI:** Incremental Fit Index.

According to Table 5, the fit indices of the scale show values in the range of excellent to acceptable levels. First, the ratio of Chi-Square value (427.71) to degrees of freedom (308) (X2 / sd = 1.38) shows a perfect fit. Moreover, Unscaled Fit Index (NNFI = .98), Comparative Fit Index (CFI = .98), and Incremental Fit Index (IFI = .98) Goodness of Fit Index (GFI = .93), Adjusted Goodness Fit Index (AGFI = .91).) and Root Mean Square Error of Approximation (RMSEA = .031) and perfect fit index values. On the other hand, Normed Fit Index

(NFI = .93) and Root Residual Mean of Squares (RMR = .20) were found to have acceptable fit index values. All these values show that the data set has a good and acceptable fit index and the scale is suitable for the model. In summary, the model formed as a result of exploratory factor analysis was verified by confirmatory factor analysis.

Reliability

The data on the variance rates and Cronbach α coefficients explained by the sub-factors of the disciplined mind scale are given in Table 6.

Table 6. Variance Ratios and Alpha Coefficients Explained by DMS's Sub-Factors

Factor	Variance Explained (%)	Alpha (α) Coefficient
1. Thinking Like a Scientist	11.610	.767
2. Interdisciplinary Connection	11.036	.769
3. Motivation to Live with Discipline	9.663	.708
4. Deep Learning	8.851	.734
5. Connection with Daily Life	6.834	.565
TOTAL	47.995	

When the Cronbach α coefficients in Table 6 are examined; It was calculated as .767 in the 1st factor, .769 on the 2nd factor, .708 on the 3rd factor, .734 on the 4th factor and .565 on the 5th factor. The total alpha value of the scale is .826. When the evaluation criteria used in the evaluation of the alpha coefficient are examined, if $0.00 \leq \alpha \leq .40$, the scale is not reliable. If $.40 \leq \alpha \leq .60$, the scale has low reliability. $.60 \leq \alpha \leq .80$ is highly reliable. If $.80 \leq \alpha \leq 1.00$, the scale is a highly reliable scale (Kalaycı, 2006). In this case, it can be said that the Disciplined Mind Scale with Cronbach α coefficient ,82, has a very high reliability.
DMS final form expressions and factor load values are given in Table 7.

Table 7. DMS Final Form and Factor Loadings

Item Number	**Factor Load**	**Items in DMS**
1	.576	I question the accuracy of what I learned in the lessons.
2	.584	I work regularly to be successful in my lessons.
3	.608	I use what I learned at school in my daily life.
4	.671	I would like to learn more from what I have learned in my lessons.
5	.589	I enjoy learning new information.
6	.546	I will definitely investigate a topic that is caught in my mind.
7	.709	I can scientifically explain the causes of natural events (rain, snow, etc.).
8	.661	I enjoy telling what I have learned to people around me.
9	.426	I'm interested in studying the development of living things (e.g. the growth process of a cat).
10	.684	I can scientifically explain how a plant grows.
11	.597	I will be happy when I have new information..
12	.638	I apply what I have just learned in my life.
13	.653	I like to share what I've learned with my friends.
14	.595	The more I learn, the happier I feel.
15	.584	**If I know math well, it would be okay if I don't know the other subjects.**
16	.625	I enjoy researching information that I am curious about.
17	.565	I can explain the reasons for events in daily life with what I learned in lessons.
18	.650	**Knowing math very well is enough to reach my dream job.**
19	.532	I can explain the reasons for events in daily life with the information I learned at school.
20	.536	I must continue to learn after I have a profession.
21	.736	**A science course is enough to be an inventor.**
22	.746	**It is sufficient to learn the courses in the field I want to specialize in.**
23	.559	**I don't want to make a new invention.**
24	.786	All the lessons I have learned are necessary for me.

25	.457	**I can't get the same pleasure from all the lessons.**
26	.713	**It is enough to study enough to pass the lessons.**
27	.700	All the lessons I have learned are important to me.

Items written in bold are negative items. The items in the final form consisting of 20 positive items and 7 negative items, totaling 27 items, were renumbered and made ready for implementation. Items numbered 3, 6, 8, 9, 12, 13, 16 constitute the "thinking like a scientist" factor, items 15, 18, 21, 22, 23, 25, 26 constitute the "interdisciplinary connection" factor, items numbered 2, 4, 5, 11, 14 constitute the "motivation to live with discipline" factor, items numbered 1, 7, 10, 17, 19 constitute the "deep learning" factor, and items numbered 20, 24, 27 constitute the "connection with daily life" factor.

Scoring Phase

There are 7 negative items (15, 18, 21, 22, 23, 25, 26) in the scale that must be reverse coded. The lowest score that can be obtained from DMS is 27 and the highest score is 135. DMS level 27-63 point range is considered as low level, 64-99 point range as medium level, 100-135 point range as high level.

Disscussion

One of the main goals in the disciplined mind is that individuals have mastered at least one discipline. Considering that the process of competence in a discipline can last up to ten years, it is thought that the disciplined mind should be developed from primary school. Disciplined mind features were examined under the themes of " thinking like a scientist, interdisciplinary connection, motivation to live with discipline, deep learning, connection with daily life".

In the theme of "thinking like a scientist" of the disciplined mind, it has been observed that the characteristics of a scientist include courage, determination to work, curiosity, impartiality, desire to share what they know with other people, tolerance, patience, and a creative personality. Science includes more than scientific knowledge. Science; It is the process of people revealing the unknown through creativity, calculation skills, curiosity, courage and patience (Bybee, Powell, & Trowbridge, 2008).

In the theme of "interdisciplinary connection" of the disciplined mind, it is seen that it is necessary to specialize in thinking skills specific to several disciplines (Gardner, 2006), since a single-disciplinary thinking style will not be sufficient. By establishing interdisciplinary connections, it is possible to view information from different angles (Şahbaz & Çekici, 2012). In order to reach permanent information, a connection must be established between the learned information (Bruner, 1999).

In the "motivation to live with discipline" theme of the disciplined mind; the characteristics of students' enjoyment of the learning process, the transformation of learning into a passion, learning after formal education, being willing to show knowledge to other people, and constantly striving to train and develop itself are seen. The concept of motivation includes complex behaviors that lead to an internal movement consistent with personality and cognitive characteristics (Krathwohl, Bloom, & Masia, 1964).

In the theme of "deep learning" of the disciplined mind, the features of being in an effort to understand and interpret instead of reading by rote, to establish a connection between knowledge, to understand the subject of learning in depth, to apply the learned information to a situation that it has not encountered before. A student who strives for in-depth learning creates a purposeful and orderly study order by truly engaging with the subject area. Students tend to investigate the reasons behind what is presented to them (Biggs & Kirby, 1983).

In the "connection with daily life" theme of the disciplined mind, we encounter the features of making a conscious and deep view about the facts about the time in which we live, and the effort to understand the world, in an effort to learn information in a meaningful way. Permanent learning takes place, as individuals can find the opportunity to make connections between what is learned by making connections with daily life (Bruner, 1999). Purposeful teaching environments that can guide how to use the learned in daily life should be designed (Dewey, 2010). What is learned at school will be of little importance unless it is used in problem solving in daily life (Entwistle, 2009).

When other studies on disciplined mind features are researched, no study was found at primary school level. Erik-Soussi (2008) investigated how the achievements of those working at the administrative level of

universities are affected by five types of mind. Miller (2011) examined the forums created for adolescent books in terms of characteristics of five areas of mind. It was seen by Yılmaz (2012) that secondary school 6th grade textbooks were examined in terms of five mind types, including the disciplined mind type. Bowen (2013) examined the four-year colleges, official colleges and university level assistant managers in the USA in terms of their institutional development according to their ability to use five areas of mind. It has been observed that these studies, which have been carried out in five areas of the mind, are generally carried out on adults and are limited in number.

When the scale development studies on the disciplined mind features were researched, it was seen that the disciplined mind scale consisting of 22 items was developed by Can Aran (2014) at the 7th grade level of secondary school. As the world turns into a more global nature, this will require a more modern way of learning and thinking (Nofsinger & Young, 2010). Since it is necessary to develop a “disciplined mind” for lifelong learning (Chang & Lee, 2008), which is a requirement of the 21st century, it is necessary to do research on what affects the disciplined mind.

No disciplined mind scale developed for different school or grade levels was found. Developed in the disciplined mind features, DMS is a 28-item scale developed at the 4th grade level of primary school. "Disciplined mind" is defined as the characteristic of thinking styles in major disciplines (Wrenn, 2010), and it takes several years of intense work with the subject area to internalize a thinking style (Schneider, 2014). By presenting the disciplined mind features of the students at the 4th grade of primary school; The effects of teaching processes or various variables in schools on the disciplined mind can be revealed.

Conclusion

In the beginning, after the trial form, which consisted of 50 items, was applied to 400 students, as a result of the analysis, 23 items were removed and a total of 27 items remained, 7 of which were negative and 20 of which were positive. It was observed that these items reflect the five basic structures taken into account in the preparation of the scale (thinking like a scientist, interdisciplinary connection, motivation tol ive with discipline, deep learning, connection with daily life). As a result of the analysis, it is seen that the factor loading values for all five factors vary between .426 and .786 at a high level. When the items in Factor I (3, 6, 8, 9, 12, 13, 16) are considered; It has been found that it measures the level of "thinking like a scientist". When the items in the factor II, (15, 18, 21, 22, 23, 25, 26) are considered; It has been determined that it measures the level of “interdisciplinary connection”. When the items (2, 4, 5, 11, 14) in Factor III are examined; It has been determined that it measures the "motivation to live with discipline" level. When the items (1, 7, 10, 17, 19) in Factor IV are examined; It has been determined that it measures the level of "deep learning". When the items in Factor V (20, 24, 27) are examined; It has been found that it measures the level of “connection with daily life”. Considering the reliability of the determined factors, $\alpha = .767$ for Factor I (thinking like a scientist), $\alpha = .769$ for Factor II (interdisciplinary connection), $\alpha = .708$ for Factor III (motivation to live with discipline), Factor IV (deep learning) and $\alpha = .734$ for Factor V (connection with daily life). The Cronbach Alpha value, which is the reliability coefficient for the whole scale, was determined as .826 ($\alpha > .70$). This indicates that the scale is highly reliable. As a result of the validity and reliability analysis of the DMS, it can be accepted as a valid and reliable measurement tool consisting of 5 sub-dimensions that measures the disciplined mind traits of primary school 4th grade students.

Recommendations

This study has a quantitative design aimed at developing a Disciplined Mind Scale (DMS). By applying DMS on different samples, DMS levels of 4th grade students can be examined in terms of various variables. Factors affecting DMS levels of 4th grade students can be investigated through experimental studies.

Notes

This scale development study is part of the second author’s master's thesis titled "Investigation of the relationship between the disciplined mind attributes and STEM attitudes of elementary school 4th grade students (Afyonkarahisar sampling)". In addition, the abstract of this study was presented as an oral presentation at the UBEK-ICSE (2019) International Science and Education Congress with the title of "Primary School 4th Grade Disciplined Mind Features Scale Development Study".

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