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Turkish Validation of STEAM Scale and Examination of Relations Between Art Attitudes, STEM Awareness and STEAM Attitudes among Pre-Service Teachers

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Abstract

The aim of this study was to adapt the STEAM Attitude Scale developed by Kim and Bolger (2017) in order to explain the STEAM attitudes of preservice teachers, and test a structural equation model composed of the attitude towards art and STEM awareness and some other variables. The study group consisted of 429 preservice teachers who were studying at education faculties of universities in five different regions in Turkey. Data collection instruments were the adapted STEAM Attitude Scale, the Attitude Towards Art Scale and the STEM Awareness Scale. In the analysis of the data, frequency, percentage, exploratory factor analysis (EFA), confirmatory factor analysis (CFA), correlation analysis, and path analysis were realized by using the SPSS 21.0 and AMOS 24.0 programs. As a result of the research, we concluded that there is a positive relationship between the STEAM attitude and STEM awareness and the attitude towards art. Thus the criterion-related validity of the adaptive STEAM attitude scale was tested. We also identified that STEM awareness, attitudes towards art, and some variables predicted STEAM attitude significantly at various levels. Alternative models were also tested and compared in the study.

Keyword: Art attitude, scale adaptation, STEAM attitude, STEM awareness, structural equation modeling

Introduction

Holistic teaching programs consisting of more than one discipline have the potential to make science and mathematics learning more meaningful and coherent for students. Over time, it has been observed that strict adherence to discipline boundaries limits the potential of teaching programs in relating the real-world problems that students see in their lives. In addition, holistic teaching programs can help students see how concepts are related to each other in order to understand phenomena from a wider perspective. Such classroom experience can be considered as a means of making learning more engaging and meaningful for students. Extensive studies on this argument are seen in the literature (Çevik, 2018a; Lin & Wang, 2018).

The teaching program that combines the contents of multiple disciplines can be expressed as holistic or interdisciplinary. According to Kim and Bolger (2017), it is possible to consider teaching programs as a process involving distinct categories in a spectrum ranging from sectioned (essentially without integration) to holistic (a highly integrated teaching program based on the interests of a group of students). In fact, some researchers suggest that each discipline offers an important objective to understand the world, and teaching programs ought to benefit from these different objectives even considering that the integration of teaching programs in real terms minimizes the discipline limits or focuses on the common points within disciplines (Lederman & Lederman, 2013).

At the same time, it is seen that the curriculum of science, technology, engineering, and math (STEM) or science, technology, engineering, art, and math (STEAM) is carried out consistently in some countries, such as the United States and Australia. Numerous studies in the relevant literature have revealed that this educational approach is of great importance for the acquisition of 21st century skills (Freeman et al., 2014; Katz-Buonincontro, 2018). However, in Turkey, a decline was observed in preferring STEM professions from 2000 to 2014 (Aydeniz et al., 2015). Furthermore, it is observed that STEM discipline graduates continue to fall behind graduates from the OECD countries in general because of the quality of education in STEM fields (Çorlu et al., 2014). The results of the OECD Programme for International Student Assessment (PISA) 2015 also support this result (OECD, 2016). Here, it can be said that influential factors include perceiving STEM as a chain of activities, considering it as a learning technique rather than an approach, and imagining that STEM occurs only when coding or experimentation is performed, as well as issues in implementing theoretical knowledge into practice or the lack of participation and permanent learning because of a technical/mechanical approach. Previous experiences have indicated that there are serious drawbacks in communication, cooperation, creativity, and critical thinking gains. At this point, students may be able to learn by exploring and experimenting and maximize interaction with their surroundings by integrating traditional STEM with art. The STEAM approach has also recently begun to be embraced more. (Ayvacı & Ayaydın, 2017; Gülhan & Şahin, 2018; Sparkes, 2017; Tüzün & Tüysüz, 2018). This approach aims to improve the affective aspect, reveal creativity skills, and increase success in these disciplines especially by rendering STEM topics more appealing and powerful (Kim & Bolger, 2016; Watson & Watson, 2013).

Theoretical Framework

Recently, art has been integrated into the STEM approach in addition to the disciplines of science, technology, engineering, and mathematics within STEM education, as art has an important feature in engineering designs. STEAM is defined as the inclusion of liberal arts and humanities in STEM education (Spector, 2015). In other words, STEAM aims to integrate art into science, technology, engineering, and mathematics to improve students' problem-solving abilities as well as to reveal their creativity and ensure they can produce artistic products with a holistic and positive perspective (Herro, Quigley, & Jacques, 2017).

Art enables students to obtain skills such as observation, visualization, handicraft, creativity, and self-confidence in the education process. These skills form the basis of scientific thinking (Cantrell, 2015). Yakman (2008) expanded the scope of STEAM by integrating art into STEM and stated that art and aesthetics should not be ignored in innovative approaches. For example, when students are asked to draw something, they need to look more closely and examine the objects more carefully in order to observe the lines and shapes of what they are depicting. So, they learn to see even the slightest differences. Students acquire the ability to see a three-dimensional space by looking at a two-dimensional drawing while learning spatial thinking. It is a skill that engineers, architects, and scientists need to acquire, which also makes it easier for students to understand difficult concepts. Students who understand how the parts of the system come together, how they interconnect, and how they are separated from each other can understand how the system works (Yokana, 2014). In addition to the science and mathematical skills needed for children to compete in the new global context, creative thinking skills from a meaningful art education should also be encouraged (Eger, 2011). STEAM can ensure the development of creative and innovative individuals, which is necessary to increase competitiveness in the global market in the 21st century (Rabalais, 2014).

Studies in the relevant literature have shown that the STEAM approach has positive effects on academic achievement, attitude and interest, motivation, self-efficacy, and creativity (Kim & Bolger, 2017; Quigley & Herro, 2016; Thuneberg, Salmi, & Bogner, 2018; Yakman & Lee, 2012). As for examining the national literature in Turkey, we observed that the studies are limited and insufficient. We saw that students' knowledge and perceptions on STEAM topics positively developed and positively affected their scientific creativity (Özkan & Umudu Topsakal, 2017; Gülhan & Şahin, 2018). Furthermore, various studies that examine the impact of gender and major variables in the awareness of teachers or preservice teachers for STEM in Turkey can be seen in the literature (Biçer, Uzoğlu, & Bozdoğan, 2019; Çevik, Şanlıtürk & Yağcı, 2018; Kızılay, 2018) Although there is an increasing interest in STEAM studies in the literature, we identified that a STEAM attitude scale has not yet been developed or adapted, and its relationship with STEM awareness and art attitudes have not been explored in Turkey. In this regard, quantitative and qualitative research is needed to examine the effectiveness of STEAM. Thus the limited number of studies on STEAM has been the basis of this research. It is emphasized that STEAM studies ought to be accelerated because examining the factors affecting attitudes of preservice teachers towards STEAM would contribute to their career developments in engineering and technology fields in that country (Henrkisen et al., 2015). In the literature, it is emphasized that integration of art and science can enable individuals to activate further parts of their brains by employing different cognitive skills (Pollock, Murray, & Yeager, 2017). Therefore, revealing how STEM awareness and art attitudes of preservice teachers, who are expected to have a wide range of impact, affect their STEAM attitudes is essential in terms of providing clues about how one develops a positive attitude towards STEAM and avoids a negative attitude toward it. We believe that that the present study would contribute to the studies in this regard in Turkey, which is a developing country as a whole. The following research questions are thus explored in the present study:

Research Questions
1. Is the adapted STEAM scale valid and reliable?
2. Is there a relationship between attitudes towards STEAM and STEM awareness and attitudes towards art?

Methods

This section gives insights into the research model, the participants in the research, the characteristics of the data collection instruments, the processes carried out during the scale development, and other data analyses.

Participants
Participants were included in the study by employing the convenience sampling method among nonrandom sampling methods. In this regard, 429 preservice teachers were involved using an online scale with Google Forms. The preservice teachers were enrolled at five different state universities in the central, south, west, north, and east of Turkey, and they participated on a voluntary basis. Five different regions were preferred in choosing the universities with official permits in order to reflect the overall country. The descriptive information about the participants is given in Table 1 below.

Table 1. Descriptive Information about the Participants

Variable	Category	N	%
Gender	Female	277	64.6
	Male	152	35.4
	TOTAL	429	100
Universities	Karamanoğlu Mehmet Bey University	212	49.42
	Muğla Sıtkı Koçman University	86	20.05
	Gazi University	51	11.88
	Bayburt University	39	9.09
	Harran University	41	9.56
	TOTAL	429	100
Departments	Primary School	122	28.44
	Guidance and Psychological Counseling	75	17.49
	Technical/Vocational Education	55	12.83
	Math Teaching	53	12.36
	Preschool Teaching	43	10.02
	Physical Education & Sports	40	9.32
	Social Sciences	20	4.66
	Art Education	12	2.79
	Science Education	9	2.09
	TOTAL	429	100

As seen in Table 1, the majority of the preservice teachers involved in the study are female. The participants who continue their undergraduate education in five different state universities from five different regions are enrolled in social studies, science, and equally weighted branches. The participants were identified within the various majors as much as possible, especially from the STEAM disciplines.

Data Collection Instruments

STEAM Attitude Scale. The STEAM Attitude Scale developed by Kim and Bolger (2017) is a Likert-type measurement tool that measures the attitudes of primary education preservices towards STEAM in Korea. In the original study initially, eight primary school teachers pre-examined the measurement tool in the scale development process for the construct validity. Then, validity and reliability controls were carried out by conducting face-to-face pretests with 119 primary teachers. Therefore, exploratory factor analysis (EFA) was realized for the construct validity. Prior to EFA, Kaiser-Meyer-Olkin (KOM) and Bartlett's Test of Sphericity tests were realized and values were found as KMO = 0.750, X^2 = 2.210276 (p <.001), which indicated that it was appropriate to perform EFA. As a result of EFA, 4 factors, those factor load eigenvalues were greater than 1 and .40. were identified. Eight items were grouped into Factor 1 (awareness), eight items in Factor 2 (perceived ability), seven items in Factor 3 (value), and eight items in Factor 4 (commitment) respectively. The results of the reliability analysis (Cronbach's alpha) were observed as .80, .81, .91 and .85 for awareness, perceived ability, value, and commitment, respectively. As a result of EFA, it was identified that the scale consisted of four dimensions and 31 items. Pretest and posttest results of the scale were compared and the study group was analyzed by *t*-test in order to identify significant changes between the attitudes of preservice teachers. After obtaining the permission from the authors via e-mail, the adaptation procedure was begun.

Language Validity

We embraced the technique proposed by Brislin, Lonner, and Thorndike (1973) in adapting the scale into Turkish. This technique includes (1) the initial translation, (2) evaluating the initial translation, (3) the reverse translation, (4) evaluating the reverse translation, and (5) receiving expert opinions. In this regard, first the translation of the scale from English into Turkish was provided independently by two experts who were proficient in English and also by two educators who were proficient in both languages and in science and math fields. In the second stage, we evaluated the Turkish scale for coherence and grammar. We especially reviewed items within the context of Turkish culture, and we made efforts to use appropriate expressions for cohesion. In this regard, we decided to include all 31 items in the scale. Subsequently, the items were translated into English and compared to the original form. In the context of the results that were very close to the original form, the scale was finalized with the opinions of a STEM expert for the final controls of the items.

Art Attitude Scale. This was developed by Dede (2016), in order to identify the attitudes of secondary and high school students towards art. The Likert-type scale consisted of 33 items and 4 factors. These factors were named as Factor 1, "Necessity of Art;" Factor 2, "Valuing Art Education;" Factor 3, "Personal Art Tendency;" and Factor 4, "Participation in Art Activities." Likert-type ratings are "Totally Agree," "Agree," "Not sure," "Disagree," and "Totally Disagree." Scale items are scored from 5, which refers to "Totally Agree," to 1, which refers to "Totally Disagree." Cronbach's Alpha reliability coefficient for the whole scale was .88, .70, .72 and .70 for the sub-dimensions respectively.

STEM Awareness Scale. This was developed by Çevik (2017), in order to identify the STEM awareness of teachers. The scale consisted of 15 items and 3 sub-dimensions ("Effect on Students," "Effect on Courses," and "Effect on Teachers"). Likert-type ratings are "Totally Agree," "Agree," "Not sure," "Disagree," and "Totally Disagree." Scale items are scored from 5, which refers to "Totally Agree," to 1, which refers to "Totally Disagree."

Cronbach's alpha reliability coefficient for the whole scale was .82, and .81, .71 and .70 for the subdimensions respectively.

Data Analysis Procedure

The study consisted of two stages. Both stages were formed in the quantitative research design. A scale adaptation was performed in the first stage. The second stage was designed in a relational research model, and we also examined the relationships between STEAM attitudes and STEM awareness and attitudes towards art. Within this context, we employed structural equation modeling (SEM), a frequently used data analysis method in relational research as it allows one to examine predictive relations at the same time between variables (Fraenkel, Wallen, & Hyun, 2012). In this method, the relationships are established between the variables that are considered by the researchers, and the model established as a result of the research is tested through research data (Cengiz & Kırkbir, 2007).

Modelling was formed within two frameworks in line with the research problems. The first one was modeled to identify the relationship between the adapted, valid, and reliable STEAM attitude scale and the STEM awareness scale and the art attitude scale. The second one was modeled to identify the extent to which STEM awareness and art attitudes of the preservice teachers participating in the study predict their STEAM attitude. Structural equation modeling (SEM), in which relationships between one or more independent variables and continuous or discrete one or more variables (Ullman & Bentler, 2003) are analyzed by path analysis (Kaplan & Haenlein, 2000), which was implemented in the modelling. The results were obtained using the AMOS 21.0 program. The reason for using this technique is that the proposed model has multiple dependent variables associated with more than independent variables in the study, and the entire model must be tested as a whole in the same process. In both models, the STEM awareness scale had 3 subdimensions, namely the effect on courses, teachers, and students; the art attitude scale had 4 subdimensions, namely the necessity of art, valuing art education, personal art tendency, and participation in art activities; and the STEAM attitude scale had 3 subdimensions, namely interest, perceived ability, and value. We considered X^2, Sd, X^2/Sd, GFI, SRMR, RMSEA, CFI, NNFI, AGFI, and NFI fit indices in the evaluation of the model fit in the SEM established for the path analysis.

CFA was performed to identify whether the factorial structure of the original form of the scale would be confirmed in the Turkish sample. The AMOS 21.0 program was used for CFA in this study. Specifically, CFA is a validation technique used in adapting the measurement tools developed in other cultures and samples. According to Sümer (2000), CFA is an analysis to evaluate the extent to which the factors formed from many variables conform to the actual data with the support of a theoretical basis. In other words, CFA aims to examine the extent to which a predetermined or imagined structure is verified with the data collected.

Findings

Findings Regarding Research Question 1

Within the scope of the adaptation of the STEAM attitude scale, findings regarding validity and reliability tests were included.

Exploratory Factor Analysis (EFA)

The study was conducted with a relatively large group of participants to identify the psychometric properties of the scale and thus the scale was digitized and converted into Google Forms. It took a participant about 15 minutes to complete the scale. EFA was performed for the construct validity. KMO and Bartlett tests were performed to test the conformity to EFA. As a result of EFA, KMO was observed as .929 and Bartlett test, $\chi 2$ was observed as 5804,496 ($p<.001$). As KMO is above .60 and $\chi 2$ is significant (Büyüköztürk, 2007), the data was appropriate for factor analysis.

Since the factors are related to each other, promax rotation was used for items those factor loading values below .33 grouped in multiple factors, and the difference between factor loadings below .10 were excluded from the scale. As a result of EFA, a three-factor structure that explained 55.37% of the total variance was obtained. This value is above the desired measurement that was suggested as 40% by Kline (1994). We rigorously paid attention to ensure that eigenvalues of items were at least 1 (Shevlin & Lewis, 1999), loading values of items were at least .30 (Martin & Newel, 2004; Schriesheim & Eisenbach, 1995), items were included in a single factor, and the difference between items grouped in two factors were at least .10 (Büyüköztürk, 2007) in identifying the items to be included in the scale in EFA. Table 2 gives loading values of the items and common factor variances of the items. Results revealed that each item had a communality value and a factor loading greater than the critical threshold (0.40) suggested by Field (2009). Cronbach's alpha reliability analysis results indicated a good homogeneity and reliability among the items. The AVE values were greater than 0.50, indicating adequate convergent validity for all constructs (Hair, Black, Babin, Anderson, & Tatham, 2006).

Table 2. Factor Loadings of the Items of the STEAM Attitude Scale and the Variances Explained by the Subscales and the Item Analyses.

Construct	Item	α	Item Total Correlation	Factor Load	Communality	Total Variance	AVE
Interest	I like to read about STEAM.	.90	.64	.72	.56	37.70	.53
	My school offers courses in STEAM.		.40	.51	.46		
	I enjoy watching TV shows involving STEAM.		.61	.67	.48		
	Courses in STEAM are available to me.		.34	.42	.40		
	I am good at projects involving STEAM.		.72	.69	.64		
	I do not worry about taking tests in STEAM.		.52	.55	.42		
	Homework in STEAM is easy.		.52	.46	.48		
	I would like to participate in more after-school programs in STEAM.		.68	.66	.54		
	I am curious about a career involving STEAM.		.73	.78	.69		
	I am interested in advanced programs involving STEAM.		.77	.77	.70		
	I intend to further develop my abilities in STEAM.		.74	.75	.69		
	I will continue to enjoy the challenge of STEAM.		.74	.77	.69		
Perceived Ability	STEAM is difficult for me.	.83	.60	.76	.67	10.38	.56
	I perform well in STEAM courses.		.70	.43	.64		
	I cannot handle advanced courses in STEAM.		.50	.73	.58		
	I struggle in STEAM courses.		.63	.81	.76		
	I do not understand STEAM.		.67	.60	.58		
Value	I do not want to learn more about STEAM.	.85	.34	.58	.42	6.83	.70
	I do not enjoy taking courses in STEAM.		.54	.70	.53		
	STEAM is important.		.63	.54	.54		
	What I learn in STEAM has no value to me.		.58	.74	.61		
	Learning STEAM will not help me.		.60	.78	.66		
	STEAM is not worth my time to understand.		.57	.78	.66		
	I would dislike more/advanced courses in STEAM.		.57	.58	.49		
	I have no interest in discovering new ways to apply STEAM.		.60	.56	.49		

In Table 2, corrected item-total correlation values were explored to examine the item validity of the scale, and these values were observed between .34 and .77. Given in the literature that items with a values of .30 and above are considered to be sufficient to distinguish the characteristics to be measured and are compatible with the sum of the scale (Büyüköztürk, 2007; Field, 2009), it can be said that all items in the scale are correlated with the total score of the scale at a moderate or high level and the item validity is ensured. These are scattered in three subdimensions as seen in the scree plot graph (Figure 1). Interest sub-factor loadings, which consisted of 12 items, ranged from .42 to .78. This explains 37.7% of the total variance of the scale. Perceived subfactor loadings, which consists of 5 items, ranged from .43 and .81. This factor explains 10.83% of the total variance of the scale. Value subfactor loadings, which consists of 8 items, ranged from .54 to .78. This factor explains 6.83% of the total variance. Results revealed that each item had a communality value and a factor loading greater than the critical threshold (0.40) suggested by Field (2009). Cronbach's alpha reliability analysis results indicated a good homogeneity and reliability among the items. The AVE values were greater than 0.50, indicating adequate convergent validity for all constructs (Hair, Black, Babin, Anderson, & Tatham, 2006).

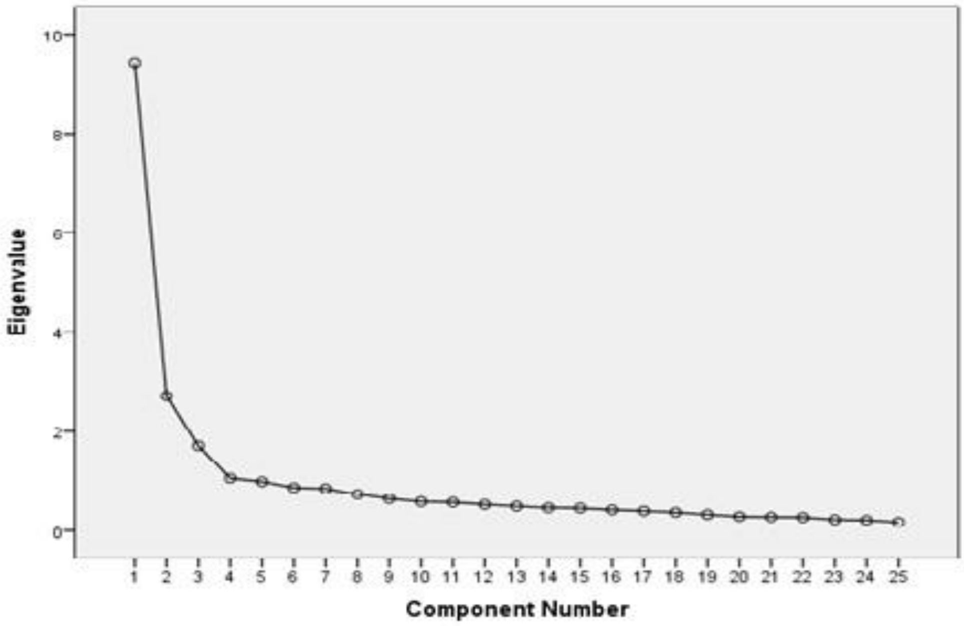

Figure 1. The scree plot graph of the eigenvalues of the items

In the scree plot graph in Figure 1, it is seen that the scale consists of three subdimensions. Correlation coefficients between these factors were examined together with the identifying the factors and then values were given in Table 3.

Table 3. Correlation Coefficient Values Between Factors

Factors	1	2	3
1	1.00	.61**	.48**
2		1.00	.55**
3			1.00

**p<.01

As seen in Table 3, Pearson correlations between the factors ranged from .48 to .61. Correlation coefficients were significant at .01 level. According to Hopkins (2014), it is suggested that effect size for correlation coefficients (r) can be neglected between .00 and .10, it can be considered as a small correlation between .10 and .30, moderate correlation between .30 and .50, high correlation between .50 and .70, very high correlation between .70 and .90, and perfect correlation between .90 and 1.00. From this point of view, it can be said that the subdimensions of the scale have a high and significant correlation with each other.

Confirmatory Factor Analysis (CFA)

The CFA results of the scale with the three sub-dimensions are shown in Figure 2.

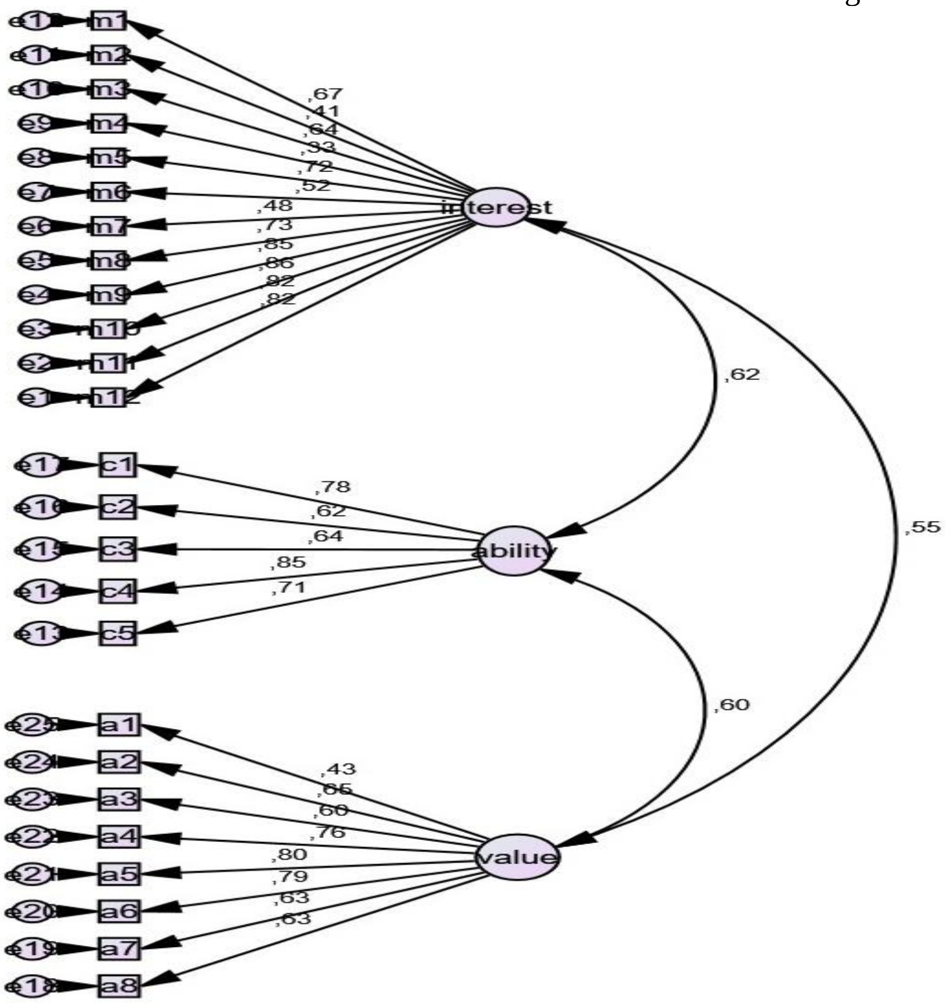

Figure 2. STEAM attitude scale sub-dimensions and standardized values of items of these dimensions

Table 4. STEAM Attitude Scale Subdimensions and Standardized Values of Items of These Dimensions

Table 4. STEAM Attitude Scale Subdimensions and Standardized Values of Items of These Dimensions

Subdimensions	Standardized values											
Interest	.67	.41	.64	.33	.72	.52	.48	.73	.85	.86	.92	.82
Ability	.78	.62	.64	.85	.71							
Value	.43	.65	.60	.76	.80	.79	.63	.63				

As seen in Figure 2 and Table 4, fit indices values were examined in order to identify whether the STEAM attitude scale consisting of 25 items and three sub-factors was compatible with CFA and to demonstrate the competence of the model tested. The fit index criterion values used to interpret the model fit were the RMSEA, SRMR, GFI/CFI/NFI. In addition, as the criteria values given in Table 4 were affected by the sample size and therefore neglected in the studies, X2 / sd statistics were also examined to interpret the model fit. According to Marsh et al. (2006), if X2 / sd is smaller than 5, it indicates adequate fit. According to Kline (1994), in the event of this statistic is smaller than 3, it indicates good fit. Values on CFA model fit are shown in Table 5.

Table 5. STEAM Attitude Scale Fit Values

Indices	Values in Scale	Perfect Fit	Good Fit	Status	Reference
X^2 /sd	2.64	X^2 /sd ≤2	X^2/ sd≤ 3	Good fit	Kline (1994), Tabachnick and Fidell, (2013)
RMSEA	.080	“RMSEA≤.05”	“RMSEA≤.08”	Good fit	Hooper, Coughlan and Mullen (2008), Brown (2006)
GFI	.90	“GFI ≥ .95”	“GFI ≥ .90”	Good fit	Hooper, Coughlan and Mullen (2008); Marsh, Hau, Artelt, Baumert, & Peschar (2006)
NFI	.94	“NFI ≥ .95”	“NFI ≥ .90”	Good fit	Tabachnick and Fidell (2007), Thompson (2004)
CFI	.95	“CFI ≥ .95”	“CFI ≥ .90”	Perfect fit	Sümer (2000), Tabachnick & Fidell (2007)
SRMR	.083	“SRMR≤ .08”	“SRMR≥.08”	Perfect fit	Marsh et al., (2006), Sümer, (2000)

As seen in Table 5, it can be said that model fit indices of the scale is good. The values obtained with EFA and CFA indicate that the scale has the model fit and the construct validity is ensured.

Findings Regarding Research Question 2

In this section, the relations between STEAM attitude and STEM awareness and Art attitude were examined, and thus the criterion-related validity of the STEAM attitude scale adapted to Turkish was also examined. The results are given in Figure 3.

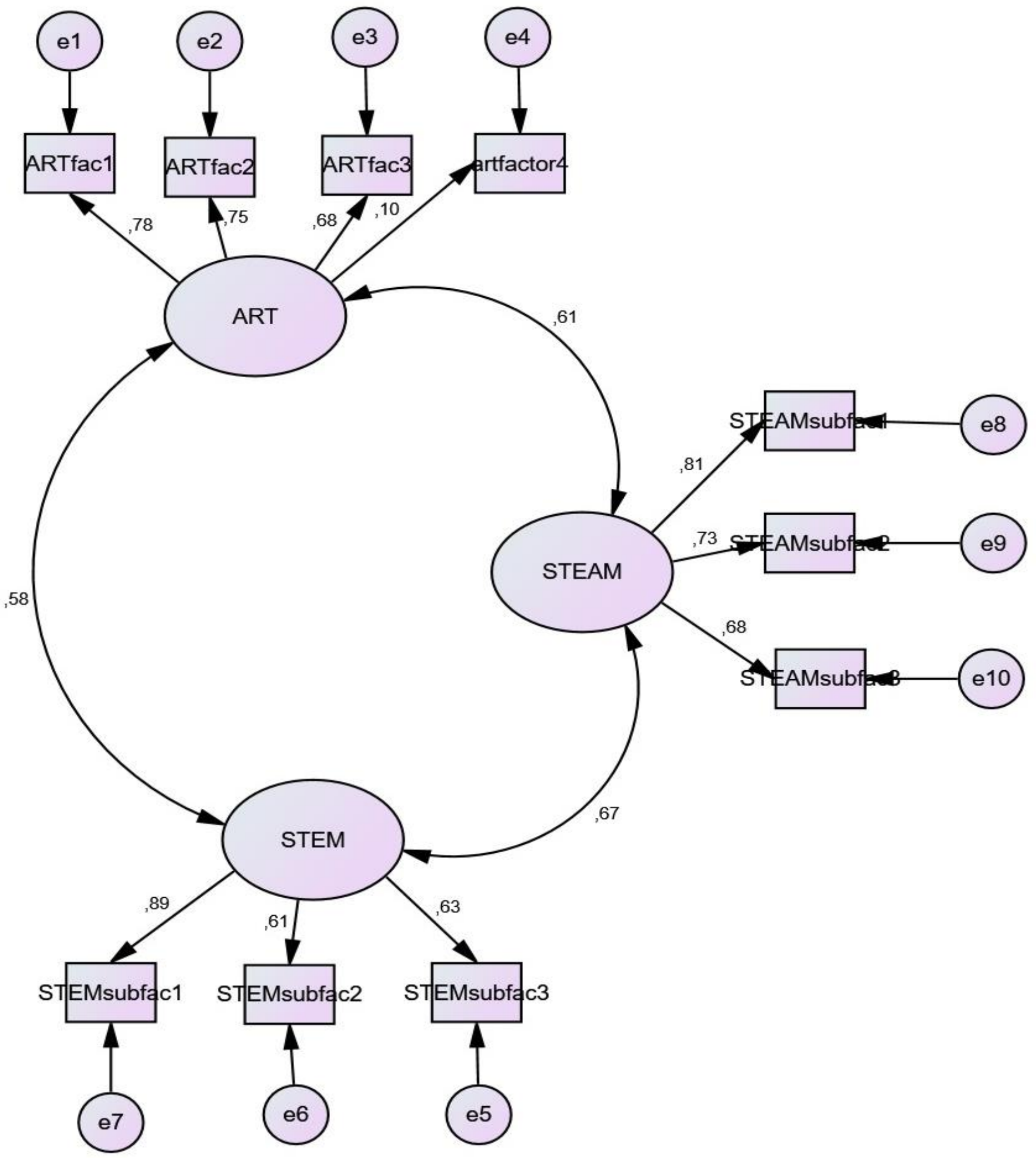

Figure 3. Relations between STEAM attitude scale and STEM awareness and Art attitude scale

Considering the relationship between the adapted STEAM attitude scale and STEM awareness scale and the art attitude scale in Figure 2, positive correlations were observed between STEAM attitude and STEM (r=0.67, p<.01) and attitude towards art (r=.61, p<.01) as well as between STEM awareness and attitude towards art (r=.58, p<.01). According to Cohen, Manion, and Morisson (2007), it is stated that correlation coefficients (r) between .20 and .35 indicate too little, between .35 and .65 indicate a little, between .65 and .85 indicate sufficient, and above .85 indicate high relationship. In this regard, it can be said that an adequate relationship appears between STEAM attitude and STEM awareness. Furthermore, low relationship appears between the STEAM attitude and attitudes toward art as well as STEM awareness and attitudes towards art. Following that, a path diagram was designed to identify the relationship between “Attitude towards STEAM,” which was the dependent variable in the study and “STEM Awareness” and “Attitude towards Art,” which were predictor endogenous variables, and “majors and gender,” which were predictor exogenous variables. This model tested using the AMOS 21.0 program and is shown in Figure 4.

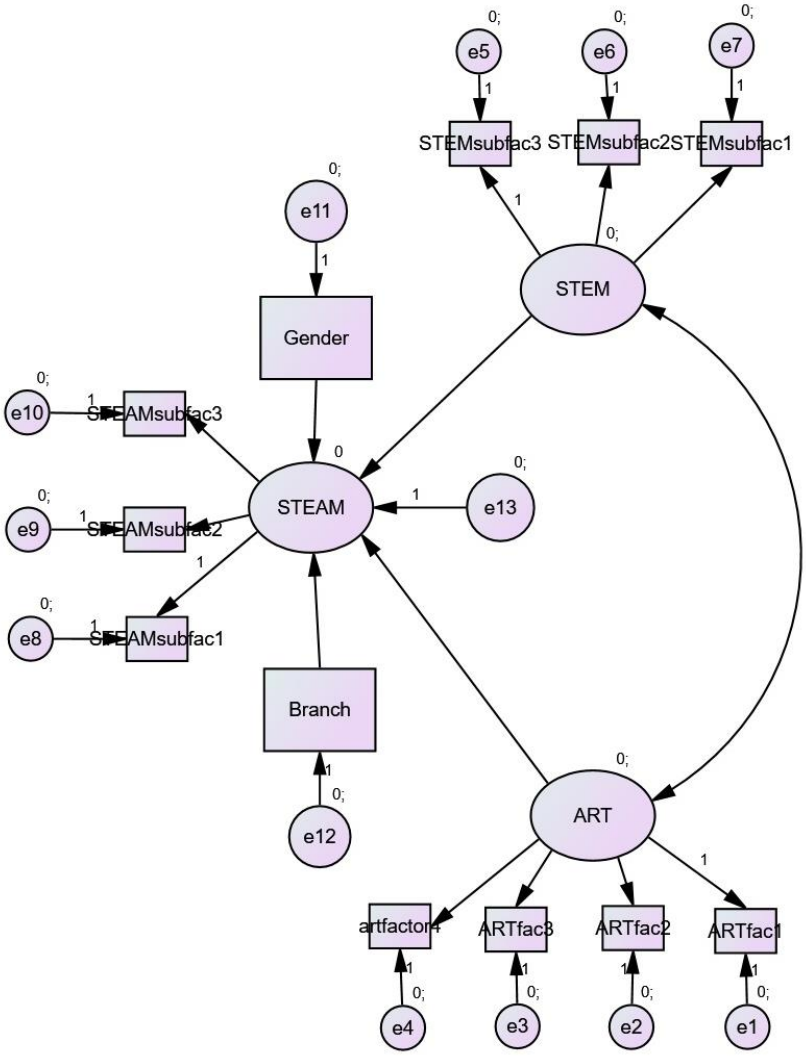

Figure 4. The initial path diagram for predicting STEAM attitude

In the model formed in Figure 3, the model fit indices were examined without applying any modification process, but it was observed that the model did not meet the criteria of goodness of fit as required (X^2 = 291.837, sd = 51, X^2/sd = 5.72, RMSEA = .09, SRMR = .044, CFI = .84, GFI = .64, NFI = .82, TLI = .76). Then the proposed modifications for the model were examined considering the theoretical basis and in accordance with these suggestions, the "branch" predictor latent variable was excluded and a series of modifications were applied by linking errors of subdimensions of the scale drawing bidirectional covariance path. In this context, the modified model is given in Figure 5 below.

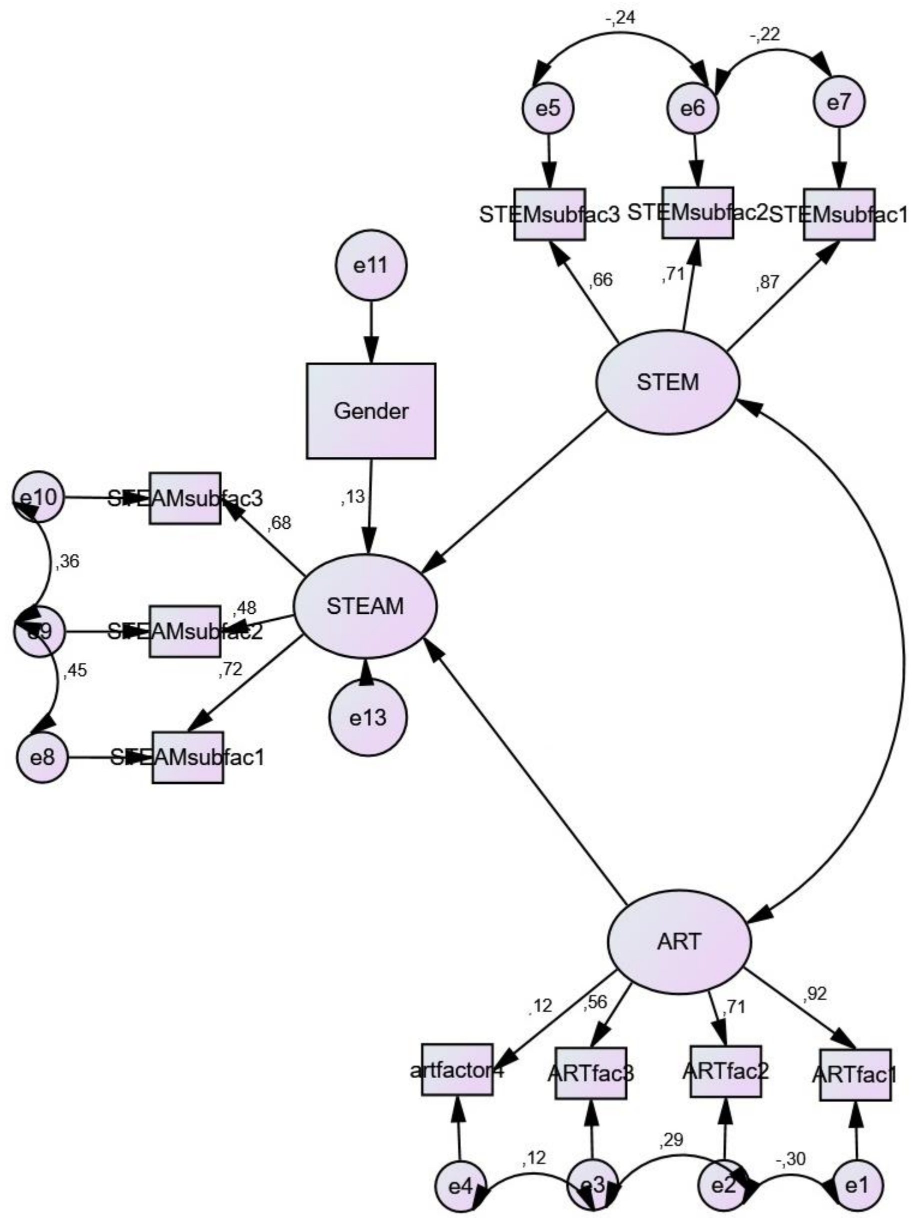

Figure 5. The model designed to predict STEAM attitude

It was observed that the model met the criteria of goodness of fit after modification. In other words, the data obtained adequately fit with the designed model and the model was verified (X^2 = 102.664, sd = 34, X^2/sd = 3.01, RMSEA = .07, SRMR = .034, CFI = .92, GFI = .96, NFI = .90, TLI = .85). After examining the goodness of fit indices values of the model, the paths in the model and parameter estimations of the model were examined. In this process, the effect size of the road coefficients as well as fit indices and R^2 were examined. According to Kline (1994), road coefficient smaller than .10 indicates small effect, moderate effect appears in the event of .30 road coefficient and there is a great effect if it is .50 or higher. In this study, road coefficients with standardized regression weight were interpreted according to these criteria (Table 6).

Table 6. Regression Coefficients and Effect Sizes of the Paths Established in the Model

Path	**Regression Coefficient**	**Effect Size**
STEAM<---STEM	.72(p<.01)	Large Effect
STEAM<---ART	.20(p<.05)	Moderate Effect
STEAM<---Gender	.13(p<.05)	Moderate Effect

As seen in Table 6, the highest standardized regression weight is the coefficient of STEM awareness (.71), followed by attitude towards art (.20) and gender (.12). It can be said that STEM awareness, which includes a large part of the STEAM disciplines, is stronger in predicting STEAM, but the attitude towards art is less effective than STEM awareness in predicting STEAM. Furthermore, we observed that the gender variable predicted STEAM attitude with a moderate effect as a latent variable. Based on this model structured within the scope of the third research question, we suggested and compared two alternative models, in which STEM awareness and the attitude towards art took part as predicted forms. Fit indices of the alternative models are given in Table 7.

Table 7. Fit indices of alternative models

	The model in which STEM awareness was predicted		**The model in which attitude towards art was predicted**	
Indices	Values in the model	Status	Values in the model	Status
X^2 /sd	2.95	Good fit	3.0	Good fit
RMSEA	.069	Good fit	.080	Good fit
GFI	.90	Good fit	.92	Good fit
NFI	.92	Good fit	.90	Good fit
CFI	.93	Good fit	.92	Good fit
SRMR	.082	Perfect fit	.081	Perfect fit

As seen in Table 7, in the first alternative model, in which STEM awareness was predicted by STEAM attitude and art attitude and the gender variable was formed as the latent predictor variable, fit indices indicated good fit in general. In addition, in the second alternative model, in which art attitude was predicted by STEM awareness and STEAM attitude and the gender variable was formed as the latent predictor variable, fit indices indicated good fit in general. After this stage, we examined the paths and parameter estimations of the model. In this regard, the regression coefficients and effect sizes of the paths described in the models are given in Table 8.

Table 8. Regression coefficients and effect sizes of the paths established in the model

The model in which STEM Awareness was predicted			The model in which attitude towards art was predicted		
Path	Regression Coefficient	Effect Size	Path	Regression Coefficient	Effect Size
STEM<---STEAM	.77(p<.01)	Large Effect	ART<---STEAM	.39(p<.05)	Moderate Effect
STEM<---ART	.20(p>.05)	-	ART<---STEM	.24(p>.05)	-
STEM<---Gender	.16(p<.05)	Moderate Effect	ART<---Gender	.03(p>.05)	-

As seen in Table 8, it was observed that the highest standardized regression weight is the coefficient of STEAM attitude (.77), followed by attitude towards art (.20) and gender (.16) in the model in which STEM awareness was predicted. The effect size of attitude towards art was not taken into consideration in predicting STEM awareness as it was not significant. However, it was identified that while STEAM attitude had a large effect in predicting STEM awareness at p<.01 level, gender as a latent variable had a moderate effect to predict STEM awareness at p<.05 level. On the other hand, the highest standardized regression weight is the coefficient of STEAM (.39), followed by STEM awareness (.24) and gender (.03) in the model in which art attitude was predicted. It was observed that STEAM attitude had a moderate effect in predicting art attitude at p<.05 level. However, since STEM awareness and gender predictors were not significant, effect sizes were not taken into consideration in predicting art attitude.

Discussions and Conclusion

The study group consisted of preservice teachers due to the importance of science, technology, engineering and mathematics in the 21st century and the need for individuals to have the skills required by this century, and therefore teachers or preservice teachers would have a vital role in teaching these fields. In today's world, multidisciplinary approaches and skills are required to solve increasingly complex problems and more research ought to be one of the priorities to design and implement more efficiently integrated STEM experiences in order to support and improve the current curriculum (English, 2017). In this context, teachers with both STEM and STEAM education awareness and attitude are needed in in-service or preservice training in order to train qualified individuals. In the literature, it is emphasized that as the knowledge of the preservice teachers about STEM education and their experiences about STEM-oriented practices increases, their cognitive process skills develop and their interests, motivations, and competences towards STEM education increase (Bozkurt Altan & Ercan, 2016; Çınar, Pırasa, & Paliç Sadoğlu, 2016). Therefore, increasing the number of STEM-trained students and employing them in industry should also be considered among the important targets for countries. STEM-trained teachers are needed in sufficient quantity and quality in the realization of this goal, as STEM-based curricula can be implemented only with qualified teachers (Wang, 2012). Thus, preservice teachers with STEM awareness and attitude will have opportunities to develop their students in this direction. Like STEM, STEAM promotes economic development by encouraging individuals to produce creative ideas (Ayvacı & Ayaydın, 2017; Braund, 2015). STEAM teaching by well-equipped teachers might inspire students to see themselves as scientists and engineers as well as creative designers (Cook, Bush, & Cox, 2017). Neurological studies and sophisticated theories also indicate that incorporation of art and science improves learning (Rabalais, 2014). Townes (2016) reveals that students who took STEM courses with art integration had higher achievement in science and reading courses, even though their mathematics achievement remained same. However, quite limited studies on STEAM education appear in Turkey (Çevik, 2018b; Duban, Aydoğdu, & Kolsuz, 2018; Gülhan & Şahin, 2018; Özkan & Umdu Topsakal, 2017). In this context, revealing the validity and reliability values of the STEAM scale to bring it in the Turkish culture formed the first research question of the study, which targeted preservice teachers. In this regard, firstly we obtained the language validity of the scale and we consulted expert opinions for this purpose. Once the language validity was obtained, we decided that 32 items were included in the scale. The finalized scale was initially piloted to examine total correlation values of the items and internal consistency values of the scale. In order to identify the implicit structure of the scale, exploratory and confirmatory factor analysis were performed respectively. The model fit of the three-factor structure obtained by exploratory factor analysis was tested with confirmatory factor analysis. We observed that model fit of the scale was good and it had construct validity. Factor loads of some items (6 items) in the original scale were quite low and these items were removed. This may be due to the fact that Korea and Turkey have different cultural compositions. It is likely that Turkish preservice teachers did not understand or interpret some items differently. Yet, the STEAM attitude scale, which was adapted within the scope of the study, emerged as a valid and reliable scale. STEAM has a direct relation with the culture as it includes art by its very nature. Liao (2016) describes STEAM as the integration of art into STEM education in transition from interdisciplinary to transdisciplinary. In order to achieve this, it is emphasized in the study of Liao that STEM practices should be understood well in the first place and STEM is an approach that an innovative society should embrace.

For the second research problem of the study, we examined the relationship between the attitude towards STEAM and STEM awareness and attitude towards art, and thus we tested the criterion validity of the adapted STEAM attitude scale. The findings indicated that the STEAM attitude scale had a moderate correlation between the STEM awareness and attitude towards art scales. Regarding the basis of STEAM on STEM education (Baek et. al., 2011; Yakman, 2008), the inclusion of art within STEM does not minimize any aspect of the STEM disciplines and actually brings them into a more powerful, attractive, and student-related format (Watson & Watson, 2013), which explains the adequate level of relationship between STEM awareness and STEAM attitude. In the study, we found that there was little relationship between STEAM attitude and attitude towards art, as well as STEM awareness and attitude towards art. In the literature, it is stated that art and science integration increases learning by eliminating success deficiencies (Rabalais, 2014). According to another study, it is reported that there is an intense relationship between science achievement, active involvement in science activities, scientific ability, liberal arts, and science (Jacobs, Finken, Griffin, & Wright, 1998). The findings of the study are in line with the literature. Considering that engineering is based on math elements along with science and technology and is also interpreted through art (Yakman, 2008), it is not a surprise that a relationship emerges between STEAM attitude and attitude towards art. STEAM is a bridge that connects STEM and art, encouraging innovation to solve real-world problems (Yokana, 2014). Even when little relation appears between STEM awareness and attitude towards art, in fact, it is in parallel with the insight that it is complementary and supportive (Sousa & Pilecki, 2013), while art and STEM disciplines may seem separate from each other.

We carried out structural equation modelling (SEM) in line with the research problem, aiming to illuminate the effect of STEM awareness, attitude towards art and some variables on STEAM attitude. In this regard, a model was designed through SEM to explore the extent to which latent and explicit variables that predict STEAM attitude predict STEM and the relationship between these variables. The initial model was revised and finalized with consideration for some modifications. The results obtained in the model and finalized by considering fit indices are as follows: STEM awareness is a very strong predictor of the attitude towards STEAM. This finding is consistent with the findings that STEM curricula integrated into art fields not only increased the academic achievement of the students in STEM but also contributed to their art abilities (Sousa & Pilecki, 2013). STEAM was also suggested as a way of enhancing students' creative and innovative problem-solving skills and increasing learning, participation, and interest in STEM-related areas (Herro, Quigley, & Jacques, 2018). It can be said that STEM actually directs STEAM, since one of the most important reasons behind STEAM is the fact that art is not different from the thinking styles of STEM fields and, additionally, a great number of engineers and scientists shape their work with artistic creativity (Plonczak & Zwirn, 2015; Watson & Watson, 2013). In short, STEM and STEAM are two intertwined educational approaches. Therefore, it is likely that STEM-derived STEAM is strongly predicted by STEM awareness.

Another finding obtained in the designed model is that the attitude towards art predicts STEAM attitude. In the literature, it was stated that art not only supports scientific thinking but also changes and improves traditional science, technology, engineering, and math, which require deeper observation, imagination, and revision (Yokana, 2014). Furthermore, it was revealed that art integration had a positive impact on students both academically and socially (May & Robinson, 2016). In light of all these, the findings are in line with the literature. However, this predictive power of art for STEAM is less effective than the predictive power of STEM awareness. This may be due to fact that art is only one discipline integrated into STEM. In addition, art comprises the cultural values that distinguish a society and symbolize its historical past (Altuner, 2007). Art education has gained importance in the early 20th century. Soon, art education was emphasized at universities and high schools, but this was not sufficient. For many years, because of policy changes, stable course time in art education especially in primary and secondary schools and the lack of interest in art education have led to an increase in the number of individuals who lack aesthetic sensibility (Altınkurt, 2005). Low predictive power of art for STEAM may be caused by the insufficient attitude towards art in Turkey. The gender variable predicts STEAM attitude with a moderate effect as a latent variable in the designed model. It is stated in the literature that experienced teachers and male teachers have an especially positive perception about the role of STEAM education (Park, Byun, Sim, Han, & Baek, 2016). This is in line with the findings of the study. For negative attitudes of female teachers, they have lower attitudes especially in the engineering and technology part of STEM applications (Mahoney, 2009), and masculine objects appear in which STEM education is provided (Cheryan, Plaut, Davies, & Steele, 2009). Similar results were obtained in the models, in which STEM awareness and attitude towards art were centralized and other explicit and latent variables were considered as predictors in order to form alternative model proposals in the light of the third research question of the study. The fit indices of both alternative models are acceptable. The first alternative model is the model in which STEM awareness was predicted. In this model, we identified that the STEAM attitude variable has a very strong effect and the latent gender variable has a moderate effect in predicting STEM awareness. In the second alternative model, in which the attitude towards art was centralized, we observed that the STEAM attitude variable predicts art with a moderate effect and the gender and STEM awareness do not have a significant effect in this model.

Limitations, Recommendations, and Future Studies

Despite this global interest (Delaney, 2014; Kim & Park, 2012), this research provides a basis for consideration because of limited research on STEAM education. However, this study was limited to preservice teachers. More extensive participation from different groups could be achieved. In addition, the study is limited due to the weak attitude towards art as expressed in the relevant literature in a developing country such as Turkey. Richer model forms could be achieved by including different explicit and latent variables.

STEAM advocates state that art integration would have a positive impact on learning and teaching by enhancing students' confidence, motivation, collaboration, and creativity (Rabalais, 2014). In particular, STEAM applications ought to be included in the agenda by policymakers to integrate into the education systems as in countries such as Korea. In this regard, more quantitative and qualitative academic studies are required to encourage the integration of STEAM into the curriculum in developing countries.

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