

Multidimensional 21th century skills scale: Validity and reliability study

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Abstract

This study aims to develop a multidimensional 21st century skills scale for adolescent and early adulthood students in the 15–25 age group. The research was conducted with 660 high school, associate degree and undergraduate students. From the item pool created during the first stage of the study, 146 items were selected in line with expert opinions. Within the scope of the validity studies, exploratory factor analysis was carried out. As a result of the analysis, a 41-item scale with five sub factors were developed. In the second stage of the study, Lisrel 8.80 program was used with confirmatory factor analysis, and the five sub-factor structure was confirmed. In the third stage of the study, the test–retest method was applied, and the mean scale scores and standard deviation values of the scale in the first and second applications were found to be 3.89, 18.21 and 3.58 and 22.19, respectively.

Keywords: 21st century skills, multidimensional 21st century skills scale, 15–25 age group, scale development.

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1. Introduction

As a result of the changes and transformations that took place on the international level in this century, significant changes have also occurred in societies. Today, developments, especially in the field of technology have an impact on the social structure. These changes and transformations in the world require individuals who have some qualifications. The skills, called 21st Century skills, include learning and renewal skills, critical thinking and problem solving skills, communication and collaboration skills, knowledge, media and technology literacy skills, social responsibility, cultural and universal awareness skills, everyday life, career orientation and career consciousness skills, initiative using and self-management skills, entrepreneurship and self-direction skills, change-transformation leadership and innovation skills (Dede, 2010; Dupuis & Persky, 2008; Herreid, 2007; Ledward & Hirata 2011; McLoughlin & Lee, 2008; Pacific Policy Research Center, 2010; Redecker et al., 2011; Wagner, 2010).

With the rapid change and transformation that took place in the world, geographical boundaries have been diminished and a global competitive environment has been formed. In this changing world, societies can have a say in the world by only educating individuals with the skills of the 21st century mentioned above. The training of individuals with the specified qualifications is only possible through education. This change and transformation in the world in the 21st century also diversify the qualifications of the individuals in need, leading to questioning of the education offered in schools. Countries that are aware of this fact are developing educational programmes to train qualified and equipped individuals to lead and form the change and transformation that can respond to the developments that may arise in the coming century (Brown, Lauder & Ashton, 2008; Gewertz, 2008; Moyer, 2016; Rotherham & Willingham, 2009; Varis, 2007).

In the past century, since it was very difficult to access information, it was important to educate individuals who acquired, learned and memorised knowledge with simple skills. That is to say, an essentialist understanding of education was dominant in the world. In the century we live, memorising knowledge now lost its importance. Today, due to technological developments, it is very easy to access any desired information. For this reason, what is now expected from individuals is to question the truth of the information that they have acquired with a constructivist approach, and to make change and transformation with the knowledge derived from existing knowledge. In addition, nowadays it is very important for individuals to be equipped with higher level skills. Therefore, it is very important to train individuals with skills such as analytical thinking, collaborative work, effective communication, leadership, science–technology–engineering–mathematics (STEM), language literacy, initiative-taking and entrepreneurship. At this point, different institutions, organisations and scholars play a guiding role in educating students in line with the 21st century talents skills, determined by the human qualities that are needed in this era.

2. Literature review

In the 21st century, skills have become more important than knowledge on specific subjects or learned knowledge. Life skills, career skills, innovative and project-oriented academic work have gained a fundamental importance. In addition, learners have to be competent in skills such as using technology, collaborative work, effective communication, digital literacy, problem solving, critical thinking, creativity and productivity and acquiring knowledge from the different sources (Gore, 2013; Voogt & Roblin, 2012). It can be argued that these skills are more related to the information society, which has an understanding of change and transformation in the direction of developments that take place in today's social, economic and technological arenas, rather than the industrial society with an understanding of industrial production style that emerged in the last century. According to Dede (2010), the 21st century skills include neither skill nor knowledge alone. 21st century skills include knowledge acquisition, comprehension and performance. In other words, the 21st century skills are the skills resulting from combined and synthesised skills and knowledge. In

short, the skills that are needed and educated in the current century are called as 21st century skills (Griffin, McGaw & Care, 2012).

2.1. The 21st century skills frameworks

The 21st century skills are categorised by various institutions and organisations and by some scientists in various subcategories. For example, The Partnership for 21st Century Skills (P21) discusses the 21st century skills in three categories: learning and innovation skills, information, media and technology skills and life and career skills (Partnership for 21st Century Skills, 2009). As a result of various workshops started in 2005, American The National Research Council has identified the 21st century skills as cognitive skills, interpersonal skills and intrapersonal skills (National Research Council, 2011). The Assessment and Teaching of 21st Century Skills (ATC 21) institution has set 21st century skills as follows: (1) *ways of thinking, which encompasses creativity and innovation, critical thinking, problem solving and decision-making, and metacognition or learning to learn*, (2) *ways of working, which includes communication and collaboration or teamwork*, (3) *tools for working, which addresses information literacy and information and communication technology (ICT) literacy and* (4) *living in the world, which includes citizenship, life and career skills, and personal and social responsibility* (Binkley et al., 2010). The Organisation for Economic Cooperation and Development (OECD) grouped 21st century skills into three classes: the skills to use interactive tools, the ability to collaborate with various heterogeneous groups, and the ability to act independently. In addition, the OECD also emphasises the ability of individuals to effectively use technology, effectively communicate and work with groups, self-management, self-defence and the ability to defend their own and others' rights as 21st century skills (Ananiadou & Claro, 2009; Dede, 2010).

In their comprehensive research, American The North Central Regional Educational Laboratory (NCREL) (2003) has listed 21st century skills as digital literacy with a new perspective in the light of recent historical events, globalisation and digital era, creative thinking, effective communication and high productivity. The Asia-Pacific Economic Cooperation (APEC) states that the knowledge, skills and attitudes necessary to compete in the 21st century workforce have become increasingly diverse, and that individuals must have a participatory understanding and the ability to use new technologies. It is also stated that individuals need to cope with rapid changes. In this context, APEC (2008) identified 21st century skills as lifelong learning, problem solving, self-management and cooperative team work.

The International Society for Technology in Education National Educational Technology Standards (ISTE NETS-S) has set the standards of skills that students should have by stating that the information and communication technologies should be at the centre of 21st century skills. Standards published by ISTE for students (NETS-S) are the standards required to assess the knowledge and skills of students, who need productive living and productive learning in a globalising and digitising world. In this context, competency areas of NETS-S, which was first introduced as 'Basic Technology Standards' in 1998 and updated in 2007, are defined as creativity and renewal, communication and cooperation, research and information flow, critical thinking problem solving and decision making, digital citizenship, technological processes and concepts (ISTE, 2007).

The Conference Board of Canada (2000), however, lists the 21st century skills as fundamental skills (communicate, manage information, use numbers, think and solve problems), personal management skills (demonstrate positive attitudes and behaviours, be responsible, be adaptable, learn continuously and work safely) and teamwork skills (work with others, participate in projects and tasks). The Queensland Curriculum and Assessment Authority (2015) has defined 21st century skills as high-priority skills and qualities that the utmost importance for helping students and learners to successfully live and work in the 21st century. The Asia Society (2011) states that in the 21st century, students must explore the world beyond their immediate surroundings in order to gain global competence, recognise their own and others' perspectives, effectively communicate and discuss ideas

and act to improve conditions. And, the American Association for School Librarians (AASL) states that in the 21st century students need to have four skill components for improving information literacy. These skills, also considered as the 21st century skills, include inquire, think critically and gain knowledge, draw conclusions, make informed decisions, apply and create knowledge, share knowledge and participate ethically and productively as members of a society, and pursue personal and aesthetic growth (AASL, 2007; 2009).

In addition to various institutions and organisations, some scientists have also worked on the 21st century skills and have determined the skills that individuals should have in the 21st century. Hixson, Ravitz and Whisman (2012) states that every student in 21st century should have these eight skills: critical thinking skills, collaboration skills, communication skills, creativity and innovation skills, self-direction skills, global connections skills, local connections skills and using technology as a tool for learning skills. In his book, titled 'The Global Achievement Gap', Wagner (2012) has addressed 21st century skills, and included critical thinking and problem solving, collaboration across networks and leading by influence, agility and adaptability, initiative and entrepreneurialism, effective oral and written communication, accessing and analysing information and curiosity and imagination among these skills. In addition, Johnson (2009) emphasises that 21st century skills are not merely technological literacy, but also include critical thinking, problem solving, effective communication and cooperative work skills necessary to succeed in daily life and business life. In general, the frameworks developed for 21st century skills tend to be largely coherent. In addition, life, career, citizenship and self-realisation skills of individuals in the 21st century are different from those needed in the 20th century.

2.2. Purpose of the study

This study aims to develop a multidimensional 21st century skills scale to reveal 21st century skills of adolescent and early adulthood students in the 15–25 age group. In the literature review, it is seen that there are many scales developed, such as 21st century skills scale for primary school students (Belet-Boyaci & Atalay, 2016), 21st century skill scale towards science skills of eighth graders (Karakas, 2015), 21st century skills scale for secondary school students (Ongardwanich, Kanjanawasee & Tuipae, 2015), 21st century skills competence perception scale for pre-service teachers (Anagun, Atalay, Kilic & Yasar, 2016) and the 21st century skills scale for in-service and pre-service teachers (Jia, Oh, Sibuma, LaBanca & Lorentson, 2016). However, there was no scale research covering a wider audience (15–25 age group) for 21st century skills in the literature. In this context, the selection of the target population of the scale in the 15–25 age group is believed to contribute to the literature in terms of both revealing the contribution of the education taken by students to the 21st century skills, and in terms of its applicability to high school and university students.

2.3. Statement of the problem

In this study, the following problems were searched:

1. Are the multidimensional 21st century skills scale to be developed and the validity and reliability coefficients high?
2. Does general of the scale and its sub-dimensions differ according to various variables?

3. Methodology

This section covers research model, participants, experimental process, data collection, validity and reliability of qualitative data and data analysis.

3.1. Research model

This research is a scale development study. In this context, detailed steps and information about the study group of the ‘Multidimensional 21st Century Skills Scale’ development project aimed at identifying the 21st century skills of the students in the 15–25 age group are discussed.

3.2. Study group

The study group consisted of students in the 15–25 age group. Participants consisted of a total of 660 students consisting of high school, associate degree and undergraduate students. The data were applied to four types of schools which were selected to cover every high school type. These include Anatolian High School, Vocational High School, Imam Hatip (Religion) High School and Fine Arts High School. For the associate degree, it was applied to two types of vocational high schools. These are Vocational School of Social Sciences and Vocational School of Technical Sciences. In Bachelor’s degree, it was applied to students from four different faculties. These include Faculty of Education, Faculty of Engineering, Faculty of Health Sciences and the Faculty of Economics and Administrative Sciences. The demographic information about the participants is shown in Table 1. It can be said that the sample, in its current form, can represent the study population.

Table 1. Demographic information of the participants

Independent variables	Groups	f	%
Gender	Female	345	57.50
	Male	315	42.50
Type of School	Anatolian High School	230	34.84
	Vocational and Technical Anatolian High School	50	7.57
	Imam Hatip High School	20	3.03
	Fine Arts High School	55	8.34
	Vocational School of Social Sciences	30	4.54
	Vocational School of Technical Sciences	35	5.31
	Faculty of Education	150	22.72
	Faculty of Engineering	20	3.03
	Faculty of Health Sciences	35	5.31
	Faculty of Economics and Administrative Sciences	35	5.31
Total		660	100

When Table 1 is examined, it can be said that participants in the 15–25 age group are studying at different school types and have a heterogeneous characteristic in terms of gender.

3.3. Data collection tool

In the first stage of the research, the literature was screened in detail to reveal what might be the signs of 21st century skills. In this context, studies conducted in the national and international arena were examined and the statements required for the scale were determined. Various studies (AASL, 2009; Fandino, 2013; Lai & Viering, 2012; Piirto, 2011; QCAA, 2015; Sanabria & Aramburo-Lizarraga, 2017; Scott, 2015; Van Laar, Van Deursen, Van Dijk & De Haan, 2017) and scales in the literature towards the 21st century skills were utilised (Belet-Boyaci & Atalay, 2016; Jia et al., 2016; Ongardwanich et al., 2015; Osman, Soh & Arsad, 2010; Siddiq, Gochyyev & Wilson, 2017; Soh, Osman & Arsad, 2012; Tondeur et al., 2015). A pool with a total of 170 items was created by taking into account the various parameters of 21st century skills. The items in the pool were evaluated by one expert in the field of science education, one in the field of education programs

and one expert in the field of guidance and psychological counselling. And, each item was evaluated in terms of ability to measure 21st century skills, relevancy with the related sub-factor, and understandability of the item. For the content validity of the items, ‘content validity constant’ developed by Veneziano and Hooper (1997) was used in the light of the views expressed by the experts. This constant rate was determined by subtracting one from the ratio of the number of experts who have expressed a positive opinion to the total number of experts for each item from. Items with a value less than 0.80 were removed. In this context, 24 questions were removed from the pool of 170 items, some items were edited and finally a 146-item questionnaire was prepared for pilot study. In the Likert-type questionnaire, items are scored on the basis of *Strongly disagree (1), Disagree (2), Neither agree nor disagree (3), Agree (4) and Strongly agree (5)* to determine the level of agreement of the students.

3.4. Data analysis

At the end of the data collection period of approximately 6 weeks, the data obtained from 660 participants were examined in detail before the analysis, and it was decided that it was appropriate to analyse 640 forms by removing 20 inappropriate forms. The validity and reliability analysis was performed based on the obtained data. According to Cakmak, Cebi and Kan (2014), the appropriate method for performing the exploratory factor analysis (EFA) and the confirmatory factor analysis (CFA) is to proceed from the data obtained from different sample groups. The sample size is estimated based on relative measures such as the number of items or factors. In general, it is desirable that the sample size should be 5–10 times of the number of items in the scale (Kline, 1994; Tavsancil, 2014). Although Kline (1994) states that a sample size of 200 individuals is sufficient as an absolute criterion, he emphasises that it is more appropriate to work with larger samples. Cokluk, Sekercioglu and Buyukozturk (2010) put forth the general rule that a minimum sample size of 300 is appropriate in factor analysis. In this context, it can be said that the sample of the study has sufficient size to perform the necessary statistical analysis.

4. Results

In this section, the findings of EFA item analysis and CFA results and assessments obtained as a result of evaluating the answers of the students in the 15–25 age group to the questions asked with the aim of scale development are given below.

4.1. Exploratory factor analysis

The Kaiser–Meyer–Olkin (KMO) coefficient was calculated to determine the suitability of the obtained data for EFA, and the significance of the Bartlett’s sphericity test was evaluated (Table 2).

Kaiser-Mayer-Olkin (KMO) value		0.88
Bartlett’s test of sphericity	Chi-square	7,605.16
	Df	820
	Sig	0.00
Cronbach’s Alpha		0.86

In the literature, if the value determined in terms of the sample size is less than 0.50, the test is terminated and the process is repeated. Within the scope of the study, values above 0.90 were considered perfect (Cokluk et al. 2010; Tavsancil, 2014). Pallant (2005) states that the value of KMO should be greater than 0.6. Considering the findings in the literature, it is seen that the KMO value of 0.88 shown in Table 1 is above the recommended values. In the study, Bartlett’s test of sphericity was significant at the level of 0.00 (Chi-Square 2 = 7,605.16, df = 820, $p = 0.000$). These values allow us to

perform factor analysis. Since the Cronbach’s Alpha value of the overall scale was 0.86, it can be said that the reliability of the data is quite high. According to the Kaiser–Guttman principle, factors with an EFA eigenvalue greater than 1 were examined and it was found that the scale has a five-factor structure. Figure 1 shows the screen plot line graph of the eigenvalues of factors.

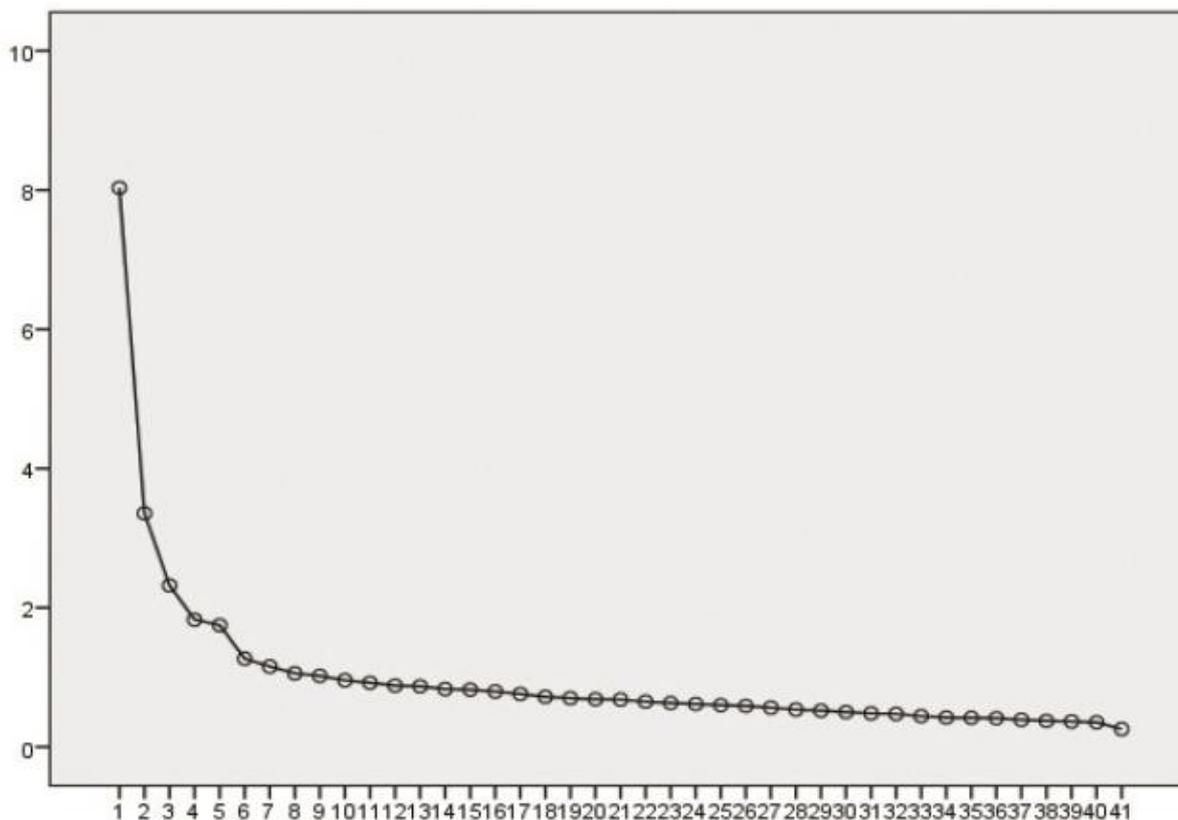


Figure 1. Line graph of the eigenvalues of the factors

To determine the number of necessary and sufficient number of factors with EFA, the percentage of the total variance explained by each factor should be examined. According to the literature, it is sufficient for each factor to explain 40% of the total variance (Buyukozturk, 2010). As another criterion to determine the number of factors to be kept, it is reported that the load values of the items under each factor should be at least 0.40 and that the loading values under the other factors should be below 0.30 (Beavers et al., 2013). In Table 3, the factor loadings of the scale items and the common factor variances of the items are given.

Table 3. Factor loadings and common factor variance of the items

Item	F 1	F 2	F 3	F 4	F 5	Mad	F 1	F 2	F 3	F 4	F 5
M 1	0.48					M135			0.64		
M 4	0.41					M136			0.70		
M 5	0.49					M137			0.72		
M 8	0.73					M141			0.63		
M12	0.68					M144			0.71		
M14	0.66					M146			0.48		
M17	0.56					M18				0.72	
M43	0.42					M21				0.62	
M44	0.58					M22				0.66	
M45	0.47					M23				0.76	

M46	0.44		M32					0.57
M48	0.46		M40					0.59
M50	0.57		M109					0.83
M53	0.46		M113					0.70
M54	0.62		M117					0.81
M75	0.42		M123					0.70
M79	0.61		Eigenvalue:	8.03	3.35	2.31	1.82	1.74
M80	0.63		Explanatory Variance:	19.58	8.18	5.65	4.45	4.26
M84	0.55		Explanatory Total				% 42.14	
M85	0.48		Variance:					
M90	0.63							
M96	0.47							
M97	0.71							
M98	0.70							
M99	0.55							

*Factor loadings less than 0.40 are not shown.

The higher the variance obtained at the end of the factor analysis, the stronger the factor structure of the scale. In social science, it is not possible to reach very high variance rates, but variance rates ranging from 40% to 60% are considered adequate (Tavsancil, 2014). To increase the variance ratio, factors that have no value in the EFA and overlapped factors were removed. EFA was continued like this, and the process was repeated. Items with a factor load less than 0.40 were removed from the scale.

As shown in Table 3, the factor loading of the first sub-factor ranged from 0.41 to 0.73 and consisted of 15 items. The second sub-factor loading varies from 0.42 to 0.71, and this factor is composed of 10 items. The third factor's loading varies between 0.48 and 0.72 and consisted of six items. The fourth factor consisted of six items with loading values ranging between 0.57 and 0.76, while the fifth factor consisted of four items with loading values ranging between 0.70 and 0.83. It is observed that these five factors explain 42.14% of the total variance. It is stated in the literature that 40%–60% of the variance explained in multiple factorial scales is sufficient (Tavsancil, 2014). The first factor was explaining 19.58% of the total variance, and called as the 'knowledge and technology literacy skills'. The second factor explains 8.18% of the total variance. This factor is named as 'critical thinking and problem solving skills'. The third factor explains 5.65% of the total variance. This factor is named as 'entrepreneurship and innovation skills'. The fourth factor explains 4.55% of the total variance. This factor is named as 'social responsibility and leadership skills'. The fifth and the last factor explains 4.26% of the total variance. This factor is named as 'career consciousness'. Some items belonging to sub-factors are given below (Table 4).

Table 4. Some items belonging to sub-factors

Sub-factors	Some items
I. Knowledge and technology literacy skills	I strive to obtain new information outside of the current information. I have an idea for changes and innovations in the world.
II. Critical thinking and problem solving skills	I talk to the subjects I have learned without thinking. I accept that every piece of information I read is true.
III. Entrepreneurship and innovation skills	I think about methods and techniques that will make people's lives easier. I produce and apply new and useful ideas that are out of the ordinary.
IV. Social responsibility	I try to communicate with people from different

and leadership skills	cultures.
	I usually work as a group leader in group work.
V. Career consciousness	I realise that the decisions I make in this life of my life will give way to my future
	I try to determine the most appropriate occupation for me by investigating the characteristics of the professions.

After identifying the factors, correlation coefficients between these factors were also examined and the obtained values were presented in Table 5.

Table 5. Correlation coefficient values between the factors

Factors	1	2	3	4	5
1	1.00	0.38*	0.52*	0.31*	0.33*
2		1.00	0.43*	0.45*	0.48*
3			1.00	0.34*	0.42*
4				1.00	0.55*
5					1.00

** $p < 0.01$.

It can be seen in Table 5 that the correlations between the factors of scale change between 0.31 and 0.52. Correlation values were found to be significant at 0.01 level. It can be said that the sub-factors of the scale have a significant relationship with each other.

4.2. Item and reliability analysis

First, factor-total correlations were calculated with the aim of determining whether each factor in the scale measures the desired feature. Second, based on the total scores, a *t*-test analysis was performed for the significance between the factor scores of the top 27% and bottom 27% groups. As a result of the *t*-test, it was determined that the *t*-values for the score differences of the factors in the top 27% and bottom 27% groups were ranging between 7.52 and 10.10. The difference between the scores of the groups was also found to be significant ($p < 0.001$). The mean of the scores of all the factors belonging of the top 27% group is higher than the factors in the bottom 27% group (Table 6).

Table 6. Independent group *t*-test results to determine the distinctiveness of scale factors and total scores

Sub-factors	Group	N	\bar{X}	SD	Fac. Tot. Cor**	t-test	
						t	p^*
1	Subgroup %27	173	61.92	7.56	0.52	7.52	0.00
	Topgroup %27	173	59.51	7.29			
2	Subgroup %27	173	21.28	5.47	0.76	8.48	0.04
	Topgroup %27	173	22.46	4.59			
3	Subgroup %27	173	36.90	6.83	0.57	10.1	0.00
	Topgroup %27	173	34.98	6.52			
4	Subgroup %27	173	15.57	9.23	0.24	8.75	0.01
	Topgroup %27	173	14.28	3.36			
5	Subgroup %27	173	26.10	3.78	0.40	9.03	0.00
	Topgroup %27	173	24.97	3.86			
Toplam	Subgroup %27	173	161.79	18.15	0.48	8.94	0.00
	Topgroup %27	173	156.21	17.66			

* $p < 0.05$; ** Fac. Tot. Cor.: factor total correlation.

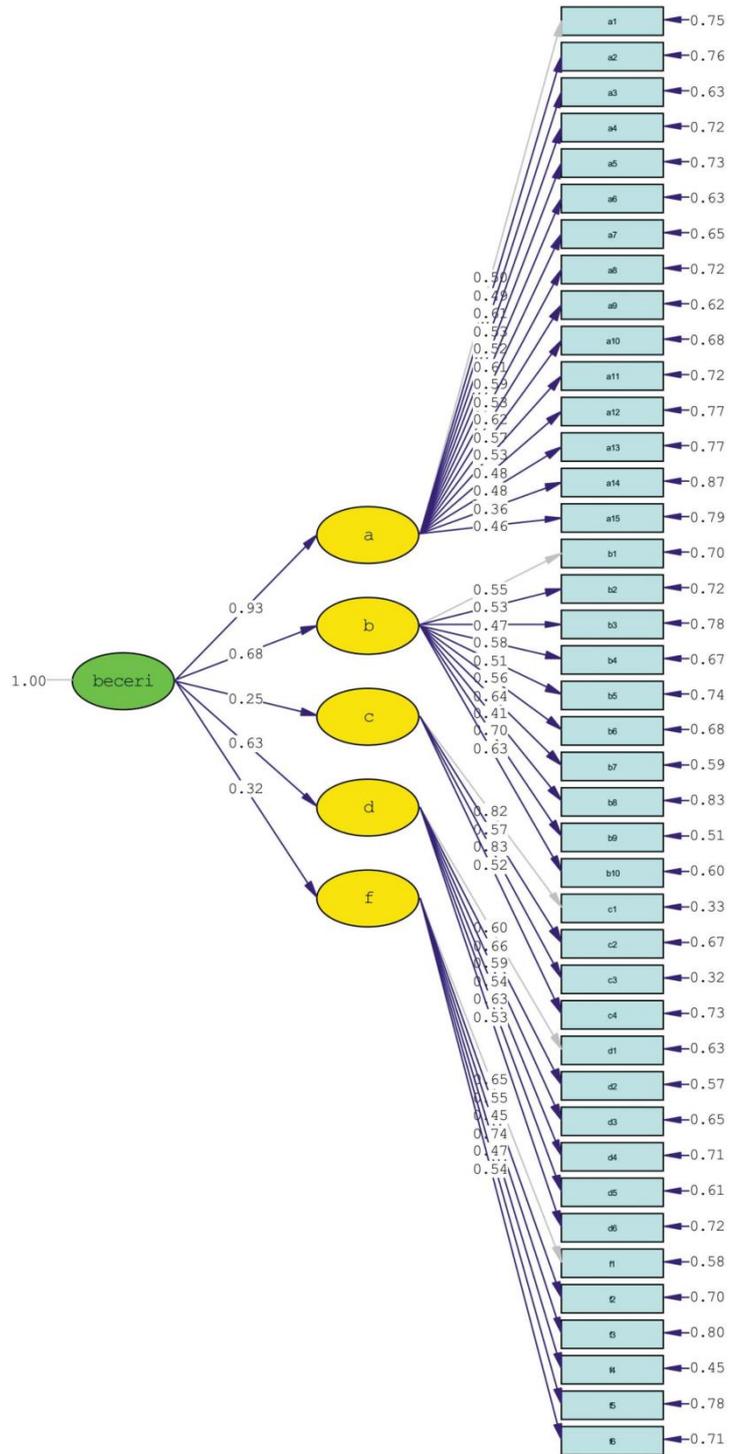
Differences for all groups were found to be statistically significant as a result of the independent samples *t*-test performed to determine whether there was a significant difference between the arithmetic mean of upper 27% and lower 27% groups determined separately according to the factors and scale total scores in order to determine the discrimination of scale factor and total scores ($p < 0.05$). These differences were in favour of the groups in top 27%. The results reveal that the scale factor and total scores are distinctive. When the factor total correlation values are examined, it is seen that each factor exceeds $r = .24$. These correlation coefficients are greater than the generally accepted value of 0.20 (Buyukozturk, 2010). Cronbach's Alpha internal consistency value was calculated for the reliability of the scale. In the literature review, the reliability coefficient of a data collection tool equal to or greater than 0.70 is indicated as adequate for reliability (Buyukozturk, 2010). The Cronbach's alpha reliability coefficient of the overall scale was 0.86, and Cronbach's alpha coefficients of the first, second, third, fourth and fifth sub-factors were found to be 0.84, 0.79, 0.76, 0.73 and 0.75, respectively. In the light of these findings, it can be said that the reliability of the scale is within acceptable limits.

4.3. Confirmatory Factor Analysis

CFA was utilised in order to assess the construct validity determined with EFA. The values found as a result of the analysis were as follows: GFI 0.90, AGFI 0.85, standardised RMR compliance index (SRMR) 0.058, NFI 0.91, NNFI 0.94 and CFI 0.95. GFI, NFI, NNFI and CFI indices above 0.90 and the RMR value below 0.08 indicate a good fit (Marsh, Hau, Artelt, Baumert & Peschar, 2006; Sumer, 2000). Looking at the value of CFI, a value over 0.95 indicates perfect fit of this index, and a NFI value above 0.90 indicates a good fit (Sumer, 2000; Thompson, 2004). Another important index of CFA, RMSEA value was found to be 0.05. 'RMSEA value ≤ 0.05 is regarded as an indication of perfect fit' (Brown, 2006). As shown in Figure 1, the correlation coefficients of the items were between 0.32 and 0.87. It is also seen that the Chi-square (χ^2) value is 2014.17 and the SD value is 774. The ratio of these values χ^2/SD (2014.17/774) gives 2.60. In the literature, the cases with this value below three are considered an acceptable fit (Cokluk et al., 2010). Obtained CFA compliance indices were evaluated in line with the literature. The relevant data are presented in Table 7.

Table 7. Literature support for CFA compliance indices

Index	Scale value	Perfect fit	Good fit	Status	References
χ^2/sd	2.60	$\chi^2/sd \leq 2$	$\chi^2/sd \leq 3$	Perfect fit	Kline, 2011; Tabachnick & Fidell, 2007
RMSEA	0.050	'RMSEA ≤ 0.05 '	'RMSEA ≤ 0.08 '	Perfect fit	Brown, 2006; Hooper, Coughlan & Mullen, 2008; Sumer, 2000
GFI	0.90	'GFI ≥ 0.95 '	'GFI ≥ 0.90 '	Good fit	Hooper et al., 2008; Hu & Bentler, 1999; Marsh et al., 2006
NFI	0.91	'NFI ≥ 0.95 '	'NFI ≥ 0.90 '	Good fit	Tabachnick & Fidell, 2007; Thompson, 2004; Marsh et al., 2006
CFI	0.95	'CFI ≥ 0.95 '	'CFI ≥ 0.90 '	Perfect fit	Hu & Bentler, 1999; Sumer, 2000; Tabachnick & Fidell, 2007
NNFI	0.94	'NNFI ≥ 0.95 '	'NNFI ≥ 0.90 '	Good fit	Sumer, 2000; Thompson, 2004; Marsh et al., 2006
SRMR	0.058	'SRMR ≤ 0.08 '	'SRMR ≥ 0.08 '	Perfect fit	Marsh et al., 2006; Sumer, 2000



Chi-Square=2014.17, df=774, P-value=0.00000, RMSEA=0.050

Figure 2. A path diagram of the CFA

4.4. Test–re-test studies

To determine the level of stability of the scale, the test–re-test method was used and scale was re-applied to 434 individuals. In the test–retest, the overall average and standard deviation of the first and second application were 3.89, 18.21 and 3.58 and 22.19, respectively. Correlation coefficient was found to be significant at $r = 0.55$ and $p = 0.05$ levels. In line with this result, it can be said that the scale has a significance in the positive direction, and it is invariant against time according to applications performed at different times.

4.5. Relationship between 21st century skills and gender factor

The t -test was used to see whether there was a significant difference between genders of participants and the total and sub-factors scores of the five factorial constructs obtained as a result of the scale development study. In the context of gender variable, the normality test was carried out for the overall scale. The skewness and kurtosis coefficients in the test indicate that the distribution of the data is homogeneous in terms of gender variation. The fact that the skewness and kurtosis coefficients are close to 0 within the ± 1 limits is regarded as evidence for the presence of normal distribution (Tabachnick & Fidell, 2007). Similarly, the slope scatter plots indicate that the data have a normal distribution. In this context, it is necessary to use parametric methods in the analysis of samples with normal distribution. For this reason, analysis was conducted with the t -test for independent groups (Table 8).

Table 8. t -test for examining participants’ genders according to their 21st century skills

Scale sub-factors	Gender	n	\bar{X}	ss	t	p
Information and Technology Literacy Skills	Female	221	53.14	14.59	-4.97	0.00*
	Male	213	59.73	12.87		
Critical Thinking and Problem Solving Skills	Female	221	18.84	3.76	0.57	0.56
	Male	213	18.63	3.71		
Entrepreneurship and Innovation Skills	Female	221	32.46	6.04	-4.02	0.00*
	Male	213	34.80	6.09		
Social Responsibility and Leadership Skills	Female	221	18.21	3.40	-3.48	0.00*
	Male	213	19.38	3.60		
Career Consciousness	Female	221	19.64	2.75	2.78	0.00*
	Male	213	18.87	2.99		
Scale Overall	Female	221	142.70	18.62	-3.79	0.00*
	Male	213	152.58	19.72		

* $p < 0.05$.

Considering the independent samples t -test results regarding the differences in the multidimensional 21st century skills scale and sub-factor averages in terms of gender variable, significant differences were found between gender variable and four sub-factor and overall scale score averages. This significance was in favour of males in knowledge and technology literacy skills sub-factor [$t_{(432)}$ first sub-factor = -4.97, $p < 0.05$], in the entrepreneurship and innovation skills sub-factor [$t_{(432)}$ third sub-factor = -4.02, $p < 0.05$], in the social responsibility and leadership skills sub-factor [$t_{(432)}$ fourth sub-factor = -3.48, $p < 0.05$] and in the overall score of the scale [$t_{(432)}$ overall scale = -3.79, $p < 0.05$]. However, there was a significant difference between the mean score of the career consciousness sub-factor, the fifth sub-factor of the scale, and the gender variable in favour of female participants [$t_{(432)}$ fifth sub-factor = 2.78, $p < 0.05$]. And, there was no significant difference between the second sub-factor of the scale, which is critical thinking and problem solving skills sub-factor [$t_{(432)}$ second sub-factor = 0.57, $p > 0.05$].

5. Discussion, conclusion and suggestions

In this study, a multi-dimensional scale consisting of five sub-factors and 41 items was developed in order to identify the 21st century skills of secondary school, associate degree and undergraduate students in the 15–25 age group in Turkey. The scale is a five-point Likert type scale. The first sub-factor of the scale consists of items measuring *knowledge and technology literacy skills*, the second sub-factor consists of the items measuring *critical thinking and problem solving skills*, the third sub-factor measures the *entrepreneurship and innovation skills*, the fourth sub-factor measures *social responsibility and leadership skills* and the fifth sub-factor consists of items measuring *career consciousness*. The factors identified were named after obtaining expert opinions.

Reliability coefficients, discriminative indices, item-total correlations, relationship analysis between sub-factors and the results of test–retest methods for the whole scale and sub-factors are as follows: The total variance explained by the five factors in the scale is 42.47%. The factor loadings of the five factors are between 0.41 and 0.83. The overall Cronbach's Alpha reliability score of the scale is 0.86 and the coefficient of each sub-factor is over 0.70. These values are consistent across the scale and between the sub-factors. Differences for all groups were statistically significant in discriminant analysis for each sub-factor ($p < 0.001$). This suggests that the scale is a distinctive feature for the overall scale and its sub-factor. Considering the total correlation values of the sub-factors, each sub-factor is above $r = 0.30$. The factor-total correlations greater than 0.30 are used as evidence for the validity of scale items (Nunnally & Bernstein, 1994). This indicates that the scales serve for the purpose of measuring the desired features.

It is seen in the literature review that there are some studies that measure the 21st century skills. One of them has been developed for science students in Malaysia and consists of five sub-factors (Osman et al., 2010). Although there are 21st century skills scales developed for primary school students (Belet-Boyaci & Atalay, 2016), secondary school students (Karakas, 2015; Ongardwanich et al., 2015), pre-service teachers (Anagun et al., 2016; Jia et al., 2016), the point that draws attention in these studies is that they have all been tailored for a specific target segment. The scale developed in this study differs from the others in terms of the coverage of all student groups in the 15–25 age range. It can be argued that the scale is different and important in terms of its wide range of measurements and its ability to measure the achievements to be gained as a result of modern teaching approaches such as STEM.

It was determined that there were significant differences between gender variable and total scale score and sub-factor score averages as a result of the t -test performed to test the developed scale, and the functionality of the scale was tested in this way. According to the result of the t -test, it was concluded that there was a significant difference in favour of males in three sub-factors, and there was another significant difference in favour females in one of the sub-factors. There was a significant difference in favour of the females in the career consciousness sub-factor. According to this result, it can be said that females are more conscious about their career planning and career choice than males.

The validity and reliability studies of the measurement tool were applied on a study group limited to 660 people with the participation of the students in the 15–25 age group. In the future studies, the areas to be implemented can be differentiated and increased, and different age groups can be included. The number of participants can be increased. However, in order to apply this scale to different study groups, it is recommended to carry out the validity and reliability studies again.

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Appendix 1. Multidimensional 21th century skills scale.

Boyutlar	M. Nu	Olcek Maddeleri	Tamamen Katilivorum	Katiliyorum	Fikrim Yok	Katilmivyorum	Kesinlikle Katilmivyorum
Bilgi ve Teknoloji Okuryazarligi Becerileri	1	Ogrenmeye karsi merakliyim.					
	4	Yeni ve farkli fikirleri dinlemeyi severim.					
	5	Mevcut bilgiler disinda yeni bilgiler edinmeye yonelik caba gosteririm.					
	8	Ulkemizde ve dunyada meydana gelen yenilikleri takip ederim.					
	12	Dunyadaki degisim ve yeniliklere yonelik fikir sahibiyim.					
	14	Cesitli kaynaklari takip ederek farkli bilgiler ve fikirler edinirim.					
	17	Guvanilir kaynaklardan arastirma yaparak yeni bilgiler edinmeyi severim.					
	43	Gunluk hayatta ne tur bilgilere ihtiyac duydugumu fark ederim.					
	44	Ihtiyac duydugum bilgiye dogru kaynaklardan ulasirim.					
	45	Elde ettigim bilgilerin dogrulukunu farkli kaynaklardan arastiririm.					
	46	Edindigim ve dogrulukuna emin oldugum bilgileri gunluk hayatimda etkili bir sekilde kullanirim.					
	48	Dogrulukuna emin oldugum bilgileri cevremdekilere aktaririm.					
	50	Yazili, isitsel ve gorsel kaynaklari duzenli takip ederim.					
	53	TV programlarinin oncesinde programin hangi kitleye hitap ettigini belirten akilli isaret sembollerinin anlamlarini bilirim.					
Elestirel DUsUnme ve Problem COzme Becerileri	54	Teknolojide meydana gelen gelismeleri yakindan takip ederim.					
	18	Bana anlatilan her bilginin dogru olduguna inanirim.					
	21	Benim gibi dusunmeyen kisilerle arkadaslik yapmak istemem.					
	22	Beni elestiren insanlardan hoslanmam.					
	23	Okudugum her bilginin dogru oldugunu kabul ederim.					
	32	Ogrendigim konular uzerinde hic dusunmeden konusurum.					
	40	Karsilastigim sorunlarla mucadele etmek yerine sorunu gormezden gelirim.					
	75	Calismalarimi genellikle istekli, coskulu ve enerjik bir sekilde surdururum.					
	79	Karsilastigim olumsuz durumlari firsata donustururum.					
	80	Zamani iyi planlar ve yonetirim.					
Girisimcilik ve Inovasyon	84	Yaptigim calismalarda farkli urunler ortaya koyarim.					
	85	Karmasik ve zor islerle ugrasmayi severim.					
	90	Yogun bir merak duygusuyla her seyi gozlemler ve incelerim.					
	96	Insanlarin hayatini kolaylastiracak yontem ve teknikler uzerine dusunurum.					
	97	Alisilmisin disinda, yeni ve yararli fikirleri uretir ve uygularim.					
	98	Gelecekte dunyada ortaya cikabilecek ihtiyaclar hakkında dusunur ve buna yonelik arastirmalar yaparim.					
	99	Gelistirdigim urunleri cevremdekilere rahatlikla sunarim.					
	109	Farkli kulturlerden insanlarla iletisim kurmaya calisirim.					
	113	Grup calismalarinda genellikle grubun lideri olarak gorev yaparim.					
	117	Kendimle birlikte cevremdeki kisilerin yeteneklerini gelistirmelerini katkida bulunurum.					
Sosyal Sorumluluk ve Liderlik Becerileri	123	Grup calismalarinin zaman kaybi oldugunu dusunurum.					

Kariyer Bilinci

- 135 Bana verilen gorevi basariyla yerine getirmek icin gayret gosteririm.
136 Gelecekte sahip olmak istedigim meslege iliskin bir kararim vardir.
137 Mesleklerin ozelliklerini arastirarak kendime en uygun meslegi belirlemeye calisirim.
141 Gelecekte yapacagim meslekte basarili olmayi isterim.
144 Hayatimin bu evresinde aldigim kararlarin, gelecegime yone vereceginin farkindayim
146 Kisisel gelismime ve gelecekteki kariyerime katkı saglayacak firsatlari degerlendiririm. (staj, kurs, kongre, seminer, egitim vb.)
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