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Ortaokul Öğrencilerinin Fen Bilimleri Dersindeki 21. Yüzyıl Becerilerine İlişkin Algıları: Çok Boyutlu Bir Yaklaşım

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ÖZET

Bu çalışmanın amacı ortaokul öğrencilerinin fen bilimleri dersinde deneyimledikleri 21. Yüzyıl becerilerini belirlemektir. Bu amaç doğrultusunda ilk olarak Fen Öğreniminde 21.yy. Becerileri ölçeğinin ortaokul öğrencileri için geçerlik çalışması yapılmıştır. Sonrasında öğrencilerin deneyimledikleri 21. Yüzyıl becerileri; öğrenme becerileri (öz yönelimli öğrenme, bilgi ve iletişim teknolojilerini kullanarak anlamlı öğrenme, iş birlikçi öğrenme), düşünme becerileri (kritik düşünme, yaratıcı düşünme, problem çözme) ve netice olarak (bilgi üretme yeterliliği) açılarından incelenmiştir. Yapılan analizlerin sonucunda, kullanılan ölçeğin Türkçe formunun öğrencilerin deneyimledikleri 21. Yüzyıl becerilerini ölçmekte kullanılmak için geçerli ve güvenilir olduğu tespit edilmiştir. Ayrıca, bu çalışmadan elde edilen veriler, 21. Yüzyıl becerilerinin fen bilimleri derslerindeki entegrasyonunun orta düzeyde olduğunu ortaya koymuştur.

Anahtar Sözcükler: 21. Yüzyıl becerileri, fen bilimleri eğitimi, ölçek uyarlaması

Middle School Students' Perceptions about Twenty-First-Century Learning Practices in Science Classes: A Multidimensional Approach

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ABSTRACT

The purpose of this study was to determine middle school students' perceptions about twenty-first-century learning practices that they experience in their science classes. For the specified purpose, firstly, Students' Perception of 21st Century Learning Practices instrument was validated for Turkish middle school students. Then, students' perceptions were examined in terms of learning processes for 21th century learning (i.e. self-directed learning, collaborative learning, and meaningful learning with ICT), thinking processes in 21th century learning (i.e. critical thinking, creative thinking, and authentic problem solving), and outcome in 21th century learning (i.e. self-efficacy for knowledge creation). According to the results, Turkish version of the instrument appears to provide a valid and reliable measure of middle school students' perceptions about twenty-first-century learning practices. Findings obtained from the administration of the instrument revealed that, integration of 21th century skills to science classes tend to be at moderate levels.

Keywords: 21st century skills, science education, scale adaptation

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1. INTRODUCTION

The most crucial role of education is raising students as self-confident, curious, innovative, and creative individuals as well as critical thinkers (Ersoy & Başer, 2013). In the field of education, instructional developments are required in order to ensure the success of raising students as innovators of the future who are embraced with all the necessary skills in the 21st century (Alismail & McGuire, 2015). However, does education equip students with the new skills of the 21st century? The general consensus among the educators, business leaders and politicians is that the gap between knowledge and skills required for being successful in life has become even more visible in the 21st century (Moylan, 2008). Especially teachers are discussing this gap as agents within this change. In the literature, it is suggested that, teachers should be aware of the distinction between

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the skills that are required to be successful in life and the skills that are taught in schools. Since one of the main roles of education is to prepare students to deal with the possible challenges of their times, there are new skills that should be integrated into lessons and taught to students because education is the key point of survival in the 21^{st} century (Trilling & Fadel, 2012).

Various definitions can be found in the literature for 21^{st} century skills. In general, collaboration, critical thinking, communication, digital literacy, citizenship, problem solving, creativity and productivity skills are mentioned in the literature as 21^{st} century skills which are perceived as essential in order to be successful in current economic state and social development of the countries (Laar, Deursen, Dijk, & Haan, 2017; Voogt & Roblin, 2012). For Trilling and Fadel (2012), these skills can be examined in three main parts. The first one is learning and innovation skills. Critical thinking, problem solving, communication and collaboration, creativity and innovation are the examples of learning and innovation skills. The second one is digital literacy skills. Information literacy, media literacy and ICT literacy are examples of digital literacy skills. The third one is career and life skills. Flexibility and adaptability, initiative and self-direction, social and cross-cultural interaction, productivity and accountability, leadership and responsibility are the examples of career and life skills. (Trilling & Fadel, 2012). This classification is detailed and well prepared. It not only focuses on academic skills, but also personal development skills, which is perfectly suitable for the multidimensional nature of the 21^{st} century. It has been shown in Trilling and Fadel's definition of 21^{st} century skills that these skills are complex and embedded in every aspect of a person's academic, daily and business life. Furthermore, they are considered necessary to be successful in life as mentioned earlier. It is believed that people with these skills become more competent, independent and practical in any challenge that life brings. They can be successful in their jobs, use technology to improve themselves, solve daily life problems practically, communicate with others effectively, and are more innovative and independent. In addition to Trilling and Fadel's (2012) definition of 21^{st} century skills, there are other frameworks about 21^{st} century skills. The first one is taken from Partnership for 21^{st} Century (2008) which divides 21^{st} century skills into three categories: learning skills, literacy skills and life skills. Learning skills include creativity and innovation, critical thinking, problem solving, communication and collaboration. Literacy skills include information, media and ICT literacy. Finally, life skills include flexibility and adaptability, initiative and self-direction, social and cross-cultural skills, productivity and accountability, leadership and responsibility (P21, 2008). The second framework is taken from The Assessing and Teaching of 21^{st} Century Skills (Binkley et al., 2012) which divides 21^{st} century skills into four categories: ways of thinking, ways of working, tools for working and living in the world. First category, ways of thinking include creativity and innovation, critical thinking, problem solving and decision making, learning to learn and metacognition. Second category, ways of working include communication, collaboration and teamwork. Third category, tools for working include information literacy, information technology and communication literacy. The final category, living in the world include life and career, personal and social responsibility (Binkley et al., 2012).

As far as these 21^{st} century skills are concerned, as the role of education is continuously changing, teachers appear to have the most important task, which is improving the skills of learners as well as keeping pace with the 21^{st} century skills for themselves (Trilling & Fadel, 2012). In order to raise students who, have these required skills for being successful, creative and practical in daily challenges, teachers should be aware of the requirements of this century such as digital literacy, productivity, critical and creative thinking, and improve themselves as creative and innovative teachers who plan their lessons carefully and integrate these particular skills into lessons. With right support and education from teachers, students can learn how to be more creative, innovative and productive. In order to raise such students, teachers need to review their attitude towards students, design a productive and constructivist classroom learning environment, use alternative strategies during instruction more often, promote discussions during lessons and use assessment techniques that focus on higher order learning. (Holbrook, 2017) In this way, teachers can promote the 21^{st} century skills of their students.

There are studies that placed emphasis on the importance of integrating 21^{st} century skills into lessons, especially in science lessons (Chai, Deng, Koh, & Tsai, 2015; Christensen & Knezek, 2015; Holbrook, 2017; Soh, Arsard, & Osman, 2010; Sukor, Osman, & Abdullah, 2010). The study conducted by Adamson and Darling-Hammond (2014) reveals that the number of countries putting emphasis on the integration of 21^{st} century skills into their curricula has been increasing and it has been observed that they have made progress. However, many countries still encounter challenges about embedding these skills into curriculum effectively. It has been further shown in the literature that the integration of skills promotes students' science achievement (Sukor, Osman, & Abdullah, 2010) and their attitude towards science (Soh, Arsard, & Osman, 2010). For this reason, every country has started to integrate the 21^{st} century skills into their science curriculum and science lessons with varying success rates.

For deeper understanding of this integration, comparing different nations' curricula and effectiveness of integration of these skills into their curricula will be beneficial. PISA is a worldwide examination which assess students learning in multiple dimensions. The dimensions that assessed by PISA are excellence and equality, policies and practices for successful schools, students' well-being, students' financial literacy and collaborative problem solving. Among these dimensions, collaborative problem solving is the dimension which could be considered as the 21^{st} century skill. When the results of this dimensions in PISA'15 are examined, it is observed that Singapore has the highest score and Turkey has almost the lowest score over 50 countries. Why is there such a dramatic score difference between these two countries? When we examine Singapore's educational system in terms of the integration of the 21^{st} century skills, it is seen that in 1997 they introduced an educational reform called 'Thinking Schools, Learning Nation'. They integrated collaboration, communication, critical and creative thinking and problem-solving skills into their curriculum, teaching and assessment techniques (Adamson & Darling-

Hammond, 2014). In 2010, Singapore Ministry of Education introduced a new framework and aimed to increase students' 21st century competencies. On the other hand, when the Turkish science curriculum is examined, it is observed that there is a list of special skills that teachers should teach in science education, which are critical thinking, decision making, creative thinking, communication, entrepreneurship, collaboration and innovative thinking. (MoNE, 2018a) One explanation for the difference in the related PISA scores of two countries, despite having a similar education system, the ineffective integration of these skills into actual classroom practices. In other words, there may be a mismatch between written curriculum and implemented curriculum in Turkey concerning these skills. So, it is important to assess the implementation of 21st century skills in Turkey.
In order to assess the effectiveness of the integration on a large scale based on students' perceptions, the present study, firstly, aims to validate Students' Perception of 21st Century Learning Practices instrument developed by Chai, Deng, Koh and Tsai (2015) for Turkish middle school students. The instrument provides a multidimensional measure of perceived twenty-first-century learning practices in science classrooms. Indeed, it assesses students' perceptions in seven sub-dimensions, namely self-directed learning, meaningful learning with ICT, collaborative learning, critical thinking, creative thinking, authentic problem solving and knowledge creation efficacy sub-dimensions. More specifically, this instrument assess students' perceptions in science classes regarding to what extent they (1) take responsibility and make plans for their own learning (i.e. self-directed learning); (2) learn meaningfully utilizing ICT (i.e. meaningful learning with ICT); (3) participate in the collective process of being a productive member of idea improvement (i.e. collaborative learning); (4) improve abilities to analyse issues, propose arguments, make decisions and resolve problems (i.e. critical thinking); (5) develop abilities to create original and proper products (i.e. creative thinking); (6) cope with ill-structured problems from daily lives (i.e. authentic problem solving); and (7) feel self-efficacious about constructing knowledge to propose solutions to problems (i.e. knowledge creation efficacy). Among these dimensions, self-directed learning, collaborative learning, and meaningful learning with ICT constitute the *learning processes* for 21th century learning. On the other hand, critical thinking, creative thinking, and authentic problem solving comprise the *thinking processes* in 21th century learning. Finally, self-efficacy for knowledge creation is the *outcome* in 21th century learning. The Students' Perception of 21st Century Learning Practices instrument which aimed to asses 21th century learning practices in terms of these dimensions was shown to have sufficient degree of reliability and validity (Chai et al., 2015).

1.2. The Purpose of the Study

The main aim of the current study is to assess middle school students' perceptions regarding twenty-first-century learning practices that they experience in their science classes using Turkish version of the Students' Perception of 21st Century Learning Practices instrument. Since one of the main roles of education is to prepare students for future challenges, assessing how these skills have been integrated into curriculum and science lessons is essential. Utilization of the adapted version of the instrument is expected to provide a detailed information about the 21st century skills integration into science lessons and effectiveness of it. Science teachers may use findings of this research in order to plan their lessons, choose effective instructional method or design classroom learning environment. Science curriculum developers may also use the findings and take necessary action for a better the integration of the 21st century skills into the objectives of the curriculum.

1.3. Research Problems

Does Turkish version of "Students' Perception of 21st Century Learning Practices" instrument provide valid and reliable measure of Turkish middle school students' 21st century skills?

What is the level of 21st century skills that Turkish middle school students experience in science class?

2. METHOD

2.1. Participants

Two independent samples were used to validate 21st Century Learning Practices instrument for Turkish middle school students and to examine their perceptions using the validated instrument. Each sample was selected utilizing convenient sampling method. Each participant was a middle school student attending a public school in central region of Turkey. Students were from medium to high socio-economic status.

Sample 1. The first sample consisted of 107 middle school students attending public schools in central region of Turkey. Of these students, 53% of them were female (n = 57) and 47% of them were male (n = 50). The participants were Grade 6 (n = 32), Grade 7 (n= 33) and Grade 8 (n = 42) students. This sample was utilized as part of the pilot study conducted to make an initial exploration of the psychometric properties of the Turkish version of the instrument.

Sample 2. The second sample consisted of 461 middle school students attending public schools in central region of Turkey. Of these students, 48.2% of them were female (n = 222) and 51.8 % of them were male (n = 239). Similar to the first sample, this sample consisted of Grade 6 (n = 185), Grade 7 (n= 137) and Grade 8 (n = 139) students. The data from the second sample were used to examine psychometric properties of the Turkish version of the instrument in detail considering findings from the pilot study and to investigate middle school students' perceptions of twenty-first-century learning practices in science classes using this instrument.

2.2. Instrumentation

Students' Perception of 21st Century Learning Practices instrument was developed by Chai, Deng, Koh and Tsai (2015). The development of this instrument was partially based on past instruments and self-constructions. The items of the self-directed learning, collaborative learning and meaningful learning with ICT were modified from earlier instruments (Lee et al. 2014) The items of critical learning were modified from Castle's survey (2006) and the items of creative learning were modified from Welch and McDowall's survey (2010). Lastly, the items of authentic problem solving and knowledge creation efficacy were developed by the Chai, Deng, Koh and Tsai (2015). Completed version of the instrument was shown to two experts and two school teachers in order to ensure its face validity and understandability among primary school students. In addition, exploratory analysis (PCA) and confirmatory factor analysis (CFA) were used by the authors in order to validate the instrument. PCA (principal component analysis) with varimax rotation was conducted to analyse the commonalities and differences between the instrument items. Furthermore, a correlation analysis of all the factors was performed to provide an opportunity to investigate the relationships between students' learning processes and thinking processes.

This instrument is a five-point Likert type self-report instrument ranging from 1 (strongly disagree) to 5 (strongly agree). The instrument consists of 32-items in 7 dimensions, namely (1) *self-directed learning (*SDL, e.g. "In this class, I can set goals for my studying", *n*=5), (2) *meaningful learning with ICT (*MLT*, e.g.* "In this class, I find out useful information on the internet to help my learning", *n=5)*, (3) *collaborative learning (COL, e.g.* "In this class, my classmates and I actively work together to learn new things", *n=5)*, (4) *critical thinking (CriT, e.g.* "In this class, I can provide reasons and evidences for my *opinions ", n=3)*, (5) *creative thinking (CreT, e.g*. "In this class I can generate many new ideas ", *n=4)*, (6) *authentic problem solving* (APS, e.g. "In this class, I practice solving real-world problems ", n=5) and (7) *knowledge creation efficacy (KCE, e.g.* "I am able to design things that may be useful *", n=5)* (Chai, Deng, Koh, & Tsai, 2015). Scale scores were determined by summing the items. A higher score in this scale indicated higher perceptions of 21st century learning practices.

During the adaptation of "Students' Perception of 21st Century Learning Practices" to Turkish, firstly, the instrument was translated into Turkish by the researchers for science classes. Accordingly, during translation, the statement "in science classes" was used instead of "in this class" used in the original version. Translated version of the instrument was examined by the experts in the field of science education, English Language and Turkish Language regarding content validity, appropriateness of the translations, clarity of the translated items, sentence structure and comprehensiveness. Based on the suggestions, some items were revised. Some words were changed with their synonyms in order to make the items clearer and understandable by middle school students. In addition, opinions of middle school students were gathered regarding clarity and understandability of the items. Then, a pilot study was conducted. Based on the statistical results as well as concerns raised by students, such as difficulty in understanding 3 items and finding these items confusing, during administration 3 items were decided to be revised. Then, the main study was conducted using the revised items. Data were collected from students' voluntary to participate by considering their science lessons and necessary permissions were received from ministry of education and their science teachers.

2.3. Context of the Study

Turkish Science Curriculum in terms of the emphasis on the 21st Century Skills: When the 2018 Turkish science curriculum (MoNE, 2018a) is examined in terms of 21st century skills and their adaptation to objectives and aims of the curriculum, it is seen that great emphasis has given to 21st century skills on the aims and competencies section. For deeper understanding, when aims of the curriculum are examined, it is stated that roles of individuals and societies are changing because of the developments in science and technology. Approaches to learning and teaching should be revised in terms of innovative and creative perspectives. Under the light of these changes, students should be defined as the ones who have critical and creative thinking skills, are innovative, determined to be successful, capable of empathy, beneficial to their culture and society and can easily solve daily life problems with the knowledge that they have learned in the school in the 21st century. Turkish science curriculum is an integrated curriculum which aim to gain these skills to students.

Moreover, the competencies part of this curriculum aims to provide students with 21st century skills which are highly related to this part of the curriculum. All the competencies that science curriculum aims about students and their connections with the dimension of the instrument are presented as follows. Firstly, digital competencies are mentioned in the curriculum and defined as 'students can use ICT effectively in order to solve daily life problems by using digital tools and improve their communication skills', which are highly related with meaningful learning with ICT dimension of the instrument. Secondly, self-learning competencies are defined as 'students can learn certain things by themselves or by a group of students. They should be capable of managing their times, controlling their own learning and gaining new skills'. Its connection with self-directed learning dimension and collaborative learning dimension of the instrument is quite clear. Thirdly, social competencies are defined in the curriculum as 'students should be aware of the fact that individuals' roles in society are becoming more collaborative and innovative. Students should be capable of effective group working, aware of their responsibilities in different groups and try to behave more consciously in these groups'. Its connection with collaborative learning dimension of the instrument is clear. Next, innovation and critical thinking competencies are represented as students' capabilities of creativity, critical thinking and reaching their goals by using these thinking skills. Also, planning and project management skills are important here. The connection of these competencies and creative and critical learning dimension is obvious. Finally, science competencies are mentioned in the curriculum and it is defined as ‘understanding the questions deeply, understanding the nature and using proper methodology and evidences in order to reach conclusion’. It is seen that science competencies are related with authentic problem solving and knowledge creation efficacy dimensions of the instrument. In other words, science competencies in Turkish science curriculum covers authentic problem solving and knowledge creation efficacy dimensions of the instrument. Because it includes how students use proper methodology and evidences to reach conclusion which is related with authentic problem solving dimension and how they understand the nature of questions and maintain their knowledge to find solutions to these questions which is related with knowledge creation efficacy.

So far, it is clear that aims of the curriculum and competencies that students should have are quite integrated with 21st century skills. When objectives are examined, it is observed that Board of Education integrated some of the 21st century skills into objectives. When 4th grades science curriculum (MoNE, 2018a) are examined, for example, it is obvious that critical thinking and creative thinking skills are the most common skills that integrated into objectives. In almost each topic, there are objectives that lead students to think connection of the topics with their daily life application. In the state of matters topic, students are expected to design an experiment by themselves which is also a good integration of critical and creative thinking. In addition, finding a solution to light and sound pollution are two of the objectives that requires critical and creative thinking and authentic problem-solving skills. Another objective is about using separation methods for solving daily life problems which is a clear integration of authentic problem-solving skills. These three skills (creative thinking, critical thinking and authentic problem solving) are well integrated into objectives. On the other hand, it is quite obvious that integration of the other four 21st century skills (self-directed learning, meaningful learning with ICT, collaborative learning and knowledge creation efficacy) is inadequate. Although the aims of the science curriculum and expected competencies are well developed with the 21st century skills, objectives can be revised and the other 21st century skills can be integrated too.

3. RESULTS

3.1. Adaptation of the Students’ Perception of the 21st Century Learning Practices Instrument

3.1.1. Pilot study

Turkish version of the “Students’ Perception of 21st Century Learning Practices” was administered to 107 middle school students (Sample 1). The data were analyzed through confirmatory factor analysis (CFA) conducted using LISREL 8.80 (Jöreskog & Sörbom, 2007) in order to validate the proposed factor structure of the original instrument. CFA results revealed that the model fit was reasonable (χ^2/df = 1.56 ; RMSEA = .05 ; SRMR = .08 ; CFI = .95 ; and NNFI = .94). However, detailed examination of factor loadings revealed that factor loading of one of the items (“In this class, I find out useful information on the internet to help my learning”; MLT5) belonging to *Meaningful learning with ICT* dimension was low. Corresponding completely standardized Lambda-X estimate was .33. In addition, removal of the item, led to an increase in the related dimension (i.e. meaningful learning with ICT). Indeed, the reliability coefficient raised to .80 from .77 after deletion of this item. It indicates that this item did not contribute total variability well and causes lower internal consistency. Thus, this item was decided to be revised to be improve its understandability and restated as “In science classes, I gather the information contributing to my learning via internet”. In addition, one item from collaborative learning dimension (i.e. “In science class, I get helpful comments about my work from my classmates”; COL5) and one item from knowledge creation efficacy dimension (i.e. “I am able to design things that may be useful in daily life by using thing are taught in science lessons”; KCE5) were revised due to students’ comments about these two items during the pilot study: the students expressed that these two items were not clearly communicated. Thus, overall, 3 items were revised after the pilot study. The reliability coefficients were found to be .86 for Self-Directed Learning, .78 for Meaningful Learning with ICT, .87 for Collaborative Learning, .74 for Critical Thinking, .74 for Creative Thinking, .86 for Authentic Problem Solving, .71 for Knowledge Creation Efficacy. After the pilot study, revised instrument was administered to Sample 2.

3.1.2. Main study

Working with a new sample (Sample 2) confirmatory factor analysis (CFA) and reliability analysis was conducted in order to analyse revised instrument. To validate the factor structure of the revised instrument, CFA was conducted and results revealed that the model fit was good (χ^2/df = 2.12; RMSEA = .05 ; SRMR = .06 ; CFI = . 97; and NNFI = .97). As demonstrated in Table 1, all pattern coefficients (i.e. completely standardized Lambda-Ksi estimates were greater than .50 except for the MLT5 and the CRET3. Hair, Black, Babin, and Anderson (2010) suggested that the standardized estimates of .50 or higher provide an indication for convergent validity. For CRET3, corresponding completely standardized Lambda-X estimate was .47. Deletion of the item did not cause an improvement in the reliability coefficient of its designated factor (i.e. creative thinking). Thus, it appeared to contribute to the total variability well. Thus, this item was decided to be retained as it is. For MLT5, on the other hand, corresponding completely standardized Lambda-X estimate was .29. In addition, removal of the item, led to an increase in the reliability of the related dimension (i.e. meaningful learning with ICT). Indeed, the reliability coefficient raised to .82 from .78 after deletion of this item. It indicates that this item did not contribute total variability well and causes lower internal consistency. In order to improve total variability and internal consistency, MLT5 was candidate for item deletion. However, according to Netemeyer, Bearden and Sharma, (2003) even though an item does not meet statistical criteria, if it makes a contribution to content validity the item can be retained in further studies. Therefore, this item was decided to retain for further investigations. Also, average variance extracted (AVE) computed for each dimension ranged from .39 to .51 implying that average completely standardized loadings were between .62 to .71. In addition, reliability coefficients that can be also utilized as an evidence for convergent validity (Hair, Black, Babin, and Anderson, 2010) were found to be high enough; coefficient alpha values were .80 for Self-Directed Learning, .78 for Meaningful Learning with ICT, .81 for Collaborative Learning, .66 for Critical Thinking, .70 for Creative Thinking, .78 for Authentic Problem Solving, and .83 for Knowledge Creation Efficacy. Mean inter-item correlations ranged from .37 to .50, providing exemplary evidence for internal consistency. Moreover, construct reliability values ordinarily utilized in SEM models were .80 for Self-Directed Learning, .79 for Meaningful Learning with ICT, .80 for Collaborative Learning, .66 for Critical Thinking, .71 for Creative Thinking, .78 for Authentic Problem Solving, and .84 for Knowledge Creation Efficacy. According to Hair et al., (2010) construct reliability of .70 or higher indicates good reliability and reliability between .60 and .70 is deemed acceptable.

Table 1.
Pattern and Structure Coefficients in the Main Study

Indicator	**Self-directed learning**	**Meaningful learning with ICT**	**Collaborative learning**	**Critical thinking**	**Creative thinking**	**Authentic problem-solving**	**Knowledge creation efficacy**
SDL1	.74	*0.33*	*0.39*	*0.60*	*0.49*	*0.49*	*0.45*
SDL2	.68	*0.30*	*0.36*	*0.55*	*0.45*	*0.45*	*0.41*
SDL3	.61	*0.27*	*0.32*	*0.49*	*0.40*	*0.40*	*0.37*
SDL4	.71	*0.32*	*0.38*	*0.57*	*0.47*	*0.47*	*0.43*
SDL5	.61	*0.27*	*0.32*	*0.49*	*0.40*	*0.40*	*0.37*
MLT1	*0.37*	.83	*0.29*	*0.26*	*0.26*	*0.27*	*0.22*
MLT2	*0.38*	.85	*0.30*	*0.27*	*0.27*	*0.28*	*0.22*
MLT3	*0.33*	.74	*0.26*	*0.23*	*0.23*	*0.24*	*0.19*
MLT4	*0.22*	.50	*0.18*	*0.16*	*0.16*	*0.16*	*0.13*
MLT5	*0.13*	.29	*0.10*	*0.09*	*0.09*	*0.09*	*0.08*
COL1	*0.35*	*0.24*	.67	*0.37*	*0.30*	*0.31*	*0.28*
COL2	*0.38*	*0.25*	.71	*0.39*	*0.32*	*0.33*	*0.30*
COL3	*0.36*	*0.24*	.68	*0.38*	*0.30*	*0.31*	*0.29*
COL4	*0.41*	*0.28*	.78	*0.43*	*0.35*	*0.36*	*0.33*
COL5	*0.30*	*0.20*	.57	*0.32*	*0.25*	*0.26*	*0.24*
CRIT1	*0.50*	*0.20*	*0.34*	.62	*0.54*	*0.47*	*0.47*
CRIT2	*0.52*	*0.20*	*0.36*	.64	*0.56*	*0.49*	*0.49*
CRIT3	*0.51*	*0.20*	*0.35*	.63	*0.55*	*0.48*	*0.48*
CRET1	*0.45*	*0.21*	*0.30*	*0.59*	.68	*0.55*	*0.58*
CRET2	*0.42*	*0.20*	*0.29*	*0.56*	.64	*0.51*	*0.55*
CRET3	*0.31*	*0.15*	*0.21*	*0.41*	.47	*0.38*	*0.40*
CRET4	*0.44*	*0.21*	*0.30*	*0.58*	.67	*0.54*	*0.57*
APS1	*0.38*	*0.19*	*0.26*	*0.43*	*0.46*	.57	*0.41*
APS2	*0.42*	*0.21*	*0.30*	*0.49*	*0.51*	.64	*0.46*
APS3	*0.40*	*0.20*	*0.28*	*0.46*	*0.49*	.61	*0.44*
APS4	*0.45*	*0.22*	*0.32*	*0.52*	*0.55*	.69	*0.50*
APS5	*0.45*	*0.22*	*0.32*	*0.52*	*0.55*	.69	*0.50*
KCE1	*0.44*	*0.19*	*0.30*	*0.55*	*0.61*	*0.52*	.72
KCE2	*0.45*	*0.19*	*0.31*	*0.57*	*0.63*	*0.54*	.74
KCE3	*0.45*	*0.19*	*0.31*	*0.57*	*0.63*	*0.54*	.74
KCE4	*0.48*	*0.21*	*0.34*	*0.61*	*0.68*	*0.58*	.80
KCE5	*0.34*	*0.15*	*0.24*	*0.43*	*0.48*	*0.41*	.56

Note: Non-italicized numbers signify the pattern coefficient for each item with its designated factor. Italicized numbers show the structure coefficient for each item with its nondesignated factors.

3.2. Examination of Students' Perceptions about 21th Century Learning Practices

Descriptive statistics was carried out to explore middle school students' perceptions about 21th century learning practices in science classes. Students' perceptions were examined in terms of learning processes for 21th century learning (i.e. self-directed learning, collaborative learning, and meaningful learning with ICT), thinking processes in 21th century learning (i.e. critical thinking, creative thinking, and authentic problem solving), and outcome in 21th century learning (i.e. self-efficacy for knowledge creation). Prior to descriptive statistical analyses, necessary inspections were carried out and it was ensured that middle school students' 21th century learning practices do not differ with respect to grade level and it is appropriate to conduct analyses using the whole data. The mean and standard deviation for each dimension of the 21th century learning practices were shown in Table 2. According to the results, it seems that students engage in the learning processes (i.e. self-directed learning, meaningful learning with ICT, and collaborative learning) and thinking processes (i.e. critical thinking, creative thinking, and authentic problem-solving) of twenty-first century learning at moderate to high levels in science classes. While the highest mean score was obtained on critical thinking, the lowest score was obtained on the meaningful learning with ICT dimension. In addition, as an outcome in twenty-first century learning, the students appeared to be self-efficacious in knowledge creation.

Table 2.
Descriptive Statistics

	M	SD
Self-directed learning	3.69	1.052
Meaningful learning with ICT	3.02	1.260
Collaborative learning	3.34	1.207
Critical thinking	3.77	1.054
Creative thinking	3.53	1.116
Authentic problem-solving	3.48	1.126
Knowledge creation efficacy	3.52	1.153

In the following sub-sections, students' responses to individual items in each dimension of the instrument is presented in detail. While presenting the data, the "strongly agree" and "agree" responses were consolidated to represent the proportions of students agreeing with the related item. Similarly, the "strongly disagree" and "disagree" responses were combined to represent the proportions of students disagreeing with the item.

3.2.1. Learning processes for 21th century learning

3.2.1.1. Students' perceptions of self-directed learning practices

As shown in Table 3, students appeared to engage in self-directed learning practices in science classes at moderate to high levels. For example, about 70 % of the participants reported that they set goals for their studying in science classes. Similarly, 68.8 % of the participants appeared to adjust the ways they study according to their progression. However, although majority of the students seemed to agree with the statements related to self-directed learning practices, with the percent of the agreements ranging from 58.9 % to 69.7 %, some of the students were found to be undecided about the statements. For example, more than one quarter of them (27 %) were undecided about the statement that "In science classes, I make plans for how I will study".

Table 3.
Frequency Distributions for Self-Directed Learning Practices Items

Item	Agree (%)	Undecided (%)	Disagree (%)
"In science classes, I make plans for how I will study"	58.9	27.5	13.8
"In science classes, I set goals for my studying"	69.7	18.5	11.8
"In science classes, I think about different ways or methods I can use to improve my study"	59.8	24.5	15.7
"In science classes, I adjust the ways I study based on my progression"	60.9	20.9	18.3
"In science classes, I try to check my progress when I study"	68.8	17.5	13.8

3.2.1.2. Students' perceptions of meaningful learning with ICT practices

Participants' responses to the items related to meaningful learning with ICT practices revealed that their disagreement level was higher for most of the items. For instance, 56.5 % of the participants disagreed with the statement that "In science classes, I use the computer to record my ideas for my learning progress" (see Table 4). Similarly, about 55 % of the students appeared not to use computers to organize and save information for their learning. Only, 29.9 % of the students agreed with the related item. However, majority of the students (78.7 %) reported that they use internet to access the information contributing to their learning. Thus, according to the results, among ICT practices, participants tend to use internet mostly to gather information to improve their learning.

Table 4.
Frequency Distributions for Meaningful Learning with ICT Practices Items

Item	Agree (%)	Undecided (%)	Disagree (%)
"In science classes, I use the computer to organize and save the information for my learning"	29.9	15.3	54.7
"In science classes, I use the computer to record my ideas for my learning progress"	25.9	17.6	56.5
"In science classes, I use the computer to remix/reorganize information from other resources"	34.1	18.5	47.4
"In science classes, I construct ICT-based materials (e.g., PowerPoint slides, word documents, mind maps) to represent my understanding"	36.0	19.4	44.6
"In science classes, I gather the information contributing to my learning via internet"	78.7	10.3	11.0

3.2.1.3. Students' perceptions of collaborative learning

Regarding participants' perceptions of collaborative learning, results showed that collaboration in science classes tend to be at moderate levels. Indeed, more than half of the students actively discuss different views that they possess about what they learn in science classes (51.5 %), actively work together to finish tasks (54.2 %), actively explain and share their understanding (58.2 %). About 60 % of the students thought that their classmates make supportive comments to them. However, the agreement (38.8 %) and disagreement (33.8) level of the students with the item "In science classes, my classmates and I actively work together to learn new things" was comparable. In addition, more than one-quarter (27.4 %) of the students were undecided on this item (see Table 5).

Table 5.
Frequency Distributions for Collaborative Learning Items

Item	Agree (%)	Undecided (%)	Disagree (%)
"In science classes, my classmates and I actively work together to learn new things"	38.8	27.4	33.8
"In science classes, my classmates and I actively discuss different views we have about things we are learning"	51.5	21.7	26.8
"In science classes, my classmates and I actively work together to complete tasks"	54.2	20.9	24.9
"In science classes, my classmates and I actively share and explain our understanding"	58.2	19.6	22.2
"In science classes, my classmates make helpful comments to me"	60.2	19.2	20.5

3.2.2. Thinking processes in 21th century learning

3.2.2.1. Students' perceptions of critical thinking

Compared to other dimensions of the 21th century learning practices, the average percentage of the agreements were found to be higher for critical thinking items (see Table 6). For instance, more than a three-quarter of the students (76.1 %) reported that they take different point of views into consideration to realize which one makes more sense. The lowest level of agreement was with the item "In science classes, I provide reasons and evidences for my opinions" (61.1 %).

Table 6.
Frequency Distributions for Critical Thinking Items

Item	Agree (%)	Undecided (%)	Disagree (%)
"In science classes, I think about other possible ways of understanding what I am learning"	66.5	20.5	12.9
"In science classes, I consider different opinions to see which one makes more sense"	76.1	15.8	8.2
"In science classes, I provide reasons and evidences for my opinions"	61.1	21.6	17.2

3.2.2.2. Students' perceptions of creative thinking

According to the results, while more than half of the participants agreed with the items about creative thinking, some of the participants were undecided about the related statements (see Table 7). For example, 53 % of the students reported that they produce new ideas in science classes. However, 28.8 % of students chose undecided option for this item. Similarly, although

57.8 % of the students agreed with the statement "In science classes, I create different solutions for a problem", almost a quarter of them (26 %) were undecided.

Table 7.
Frequency Distributions for Creative Thinking Items

Item	Agree (%)	Undecided (%)	Disagree (%)
"In science classes, I generate many new ideas"	53.0	28.8	18.2
"In science classes, I create different solutions for a problem"	57.8	26.0	16.2
"In science classes, I suggest new ways of doing things"	53.6	21.9	24.5
"In science classes, I produce ideas that are likely to be useful"	59.4	24.5	16.1

3.2.2.3. Students' perceptions of authentic problem-solving

As shown in Table 8, students appeared to have opportunities to learn about real-life problems (56.8 %), apply their knowledge to deal with them in science classes (69.6 %). However, less than half of the students (48.2 %) thought that they are challenged by various real-world problems such as environmental issues. Quite a few students appeared to be undecided on the items of the authentic problem-solving dimension. For example, 28.3% of the students were undecided about the statement "In science classes, I practice solving real-world problems".

Table 8.
Frequency Distributions for Authentic Problem-Solving Items

Item	Agree (%)	Undecided (%)	Disagree (%)
"In science classes, I investigate the reasons that give rise to real-world problems"	52.5	24.1	23.5
"In science classes, I learn about real-life problems that people have"	56.8	22.4	20.7
"In science classes, I am challenged by many real-world problems (e.g., water shortage, environmental issues)"	48.2	27.2	24.7
"In science classes, I practice solving real-world problems"	53.2	28.3	18.4
"In science classes, I apply the knowledge I have to solve real-life problems"	69.6	19.0	11.3

3.2.3. Outcome in 21th century learning

3.2.3.1. Students' perceptions of knowledge creation efficacy

Students' responses to knowledge creation efficacy items revealed that they appear to feel self-efficacious to create new ideas about what they are learning in science classes (65.7 %). However, 19% of the students were undecided on this item. In fact, more than a few students were undecided about the items in this dimension. For example, approximately 30 % of the students were undecided about the statement "In science classes, I am able to create useful knowledge on my own" (see Table 9). Percentage of the agreement on this item was 51.7 %. Thus, according to the results, although students, in general, seemed to feel self-efficacious in knowledge creation as reflected by their agreement with the related items, several students appeared to be undecided.

Table 9.
Frequency Distributions for Knowledge Creation Efficacy Items

Item	Agree (%)	Undecided (%)	Disagree (%)
"In science classes, I am able to build explanations/theories about things related to the issues that I am learning"	60.7	21.6	17.7
"In science classes, I am able to connect different ideas to form new ideas"	58.7	25.5	15.8
"In science classes, I am able to create useful knowledge on my own"	51.7	29.8	18.6
"In science classes, I am able to generate new ideas about what I am learning"	65.7	19.1	15.2
"I am able to design things that may be useful in daily life using what I learned in science classes"	49.2	25.5	25.3

4. DISCUSSION

4.1. Adaptation of the Students' Perception of 21st Century Learning Practices Instrument

The main purpose of this study was to determine middle school students' perceptions about twenty-first-century learning practices that they experience in their science classes. For the specified purpose, firstly, "Students' Perception of 21st Century Learning Practices" instrument was adapted to Turkish (Chai, et al., 2015). CFA results from the main study provided a good model fit. Completely standardized Lambda-Ksi estimates of all items were greater than .50 except for MLT5 and CRET3 items. This finding provided an evidence for convergent validity (Hair et al, 2010). When CFA and reliability analyses results for MLT5 and CRET3 were examined in detail, it was found that presence of CRET3 belonging to creative learning dimension in the instrument was not psychometrically problematic. However, completely standardized Lambda-Ksi estimate of MLT was very low (.29) and removal of this item lead to an improvement in internal consistency. In spite of these findings, considering the contribution of the MLT5 to content validity, it was decided to be retained. In fact, Netemeyer, Bearden and Sharma, (2003) suggested that even if an item does not meet statistical criteria, if it contributes to content validity, the item can be used in further studies. Thus, although MLT5 and CRET3 did not meet the criteria for convergent validity with completely standardized loadings less than .50, they were decided to be included in the instrument. Actually, the AVE value was .46 for meaningful learning with ICT and .39 for creative learning indicating that the average completely standardized loadings for these dimensions to which these items belong were .67 and .62, respectively. Results of the reliability analyses, which can also be used as an evidence for convergent validity, showed that coefficient alpha values were between .66 to .83, and mean inter-item correlations provided an exemplary evidence for internal consistency. In addition, the construct reliability values were found to range from .66 to .84. According to Hair et al, 2010, the values between .60 and .70 are acceptable. At this point it is important to note that the reliability coefficient of .66 belongs to critical thinking dimension which consists of only 3 items. Because reliability is sensitive to sample size and higher number of items are generally coupled with higher reliability values (Netemeyer, Bearden, and Sharma, 2003), additional items can be written for this dimension to improve its internal consistency.

Concerning discriminant validity, confidence intervals (±2 standard errors) around the phi coefficients not including a value of 1 suggested a discriminant validity evidence. Overall, the results indicated that Turkish version of the Students' Perception of 21st Century Learning Practices" instrument with 7 dimensions provides and valid and reliable measure of middle school students' perception about twenty-first century learning practices that they experience in their science classes. Accordingly, the data from sample 2, was used to investigate these perceptions in detail.

4.1.1. Learning processes for 21th century learning

In the instrument, self-directed learning, collaborative learning and meaningful learning with ICT dimensions are mentioned as learning practices. Developers of this instrument (Chai and his colleagues) tested it with 482 primary school students, who live in Singapore and aged from 11 to 13. Their results about learning practices showed that, mean of self-directed learning is 3.74, collaborative learning is 3.55 and meaningful learning with ICT is 3.26. When these results are compared with our main study's results, it is observed in our main study that, means are lower comparing to Chai's results. The reason for this finding may be that educational reform in Singapore mentioned earlier in the paper aim the integration of critical thinking, problem solving, decision-making, collaboration and innovation into curriculum, lessons and eventually students' lives (Adamson & Darling-Hammond, 2014). Although, 21st century skills were also intended to be integrated to Turkish science curriculum, this integration appears not to be as successful as that of Singaporean curriculum, as reflected by the students' perceptions obtained from these two countries. In the following paragraphs, the results obtained from the current study, will be discussed for each 21th century learning practices in detail.

When the self-directed learning results of the main study are examined, it is seen that, majority of the students agreed with the statements but there were also many undecided students. Considering the fact that self-directed learning is about both internal characteristics of students and external factors, learning environments, as an external factor, should be designed so that students experience self-directed learning (Saeid & Eslaminejad, 2016). This could be accomplished by providing students with opportunities to study by themselves or collaboratively with others (Fahnoe & Mishra, 2013). In this way undecided responses can be avoided and students' self-directed learning can be enhanced. In addition the level of students' self-directed learning can be related to their academic self-efficacy: It is obvious in the literature that, learning is an intentional and a purposeful process generally maintained by behavioral activities of students. Students need to accept the responsibility of their decisions about objectives and activities (Long & Huey, 2009). Such behavioral activities can be related to students' self-efficacy perceptions. Accordingly, one can expect that, if there is lack of self-efficacy, they students may not be able to adapt self-directed learning to their own learnings. Although this explanation is speculative, it warrants further investigation.

Regarding meaningful learning with ICT dimension, mean score was found to be 3.02 which represents students' low engagement with this dimension. Thus, it appears that there is an insufficient integration of this dimension into the classroom practices. In addition, the low score obtained on this dimension may suggest the usage of ICT for leisure not for educational purposes by students. In fact, there were some student comments related to the items of this dimension: Some students stated that they prefer to play computer games and some of them just expressed that they use ICT for only leisure. However, effective integration of ICT to science classes can create learning environments leading students to use ICT for their own meaningful learning not only for leisure and teachers play significant role at this point (Uluyol & Şahin, 2014). Actually, teachers' motivation in here play as a determinant factor because motivated teachers integrate ICT at higher levels. So, the connection between motivated teachers' usage of ICT in lessons and students' usage of ICT for educational purposes is obvious. Accordingly, it is suggested that teachers share their best practices about usage of ICT during lessons with other teachers so that they provide students with more effective leaning environment integrating ICT (Skryabin, Zhang, Liu, & Zhang, 2015).

Moving on now to consider collaborative learning results based on students' perceptions, findings, in general, revealed that, collaborative learning in science classes is at moderate with a mean of 3.34. The lowest level of agreement was on the item "In science classes, my classmates and I actively work together to learn new things (38.8 %)". This finding suggests that although, it is known that group works are carried out in science classes, questioning the effectiveness of these group works, in terms of students collaborative learning skills, is necessary. In addition, teachers' classroom management skills and collaborative learning knowledge is quite important in group works. Actually, educational systems must give emphasis on collaborative learning-centred environment where students can internalize the topics and respond to other students' ideas (Boholano, 2017).

4.1.2. Thinking processes in 21th century learning

In the instrument, critical thinking, creative thinking and authentic problem-solving dimensions are mentioned as thinking practices. Critical thinking is generally described as a metacognitive process that requires other skills such as evaluation, observation, inferring, analysis, application etc. When a person uses critical thinking appropriately, reaching logical conclusion to an argument or a problem become easier. It is obvious that, critical thinking skills are crucial in the frame of education because it promotes students' understanding of complex subjects meaningfully ang go beyond the just memorizing (retrieved from Dwyer, Hogan, & Stewart, 2014). In addition, these skills are also important for social and personal contexts because people should have good decision-making skills and practical problem-solving skills on their daily lives (Ku, 2009). When the main study results are examined, it is seen that mean of the critical thinking dimension is 3.77 which demonstrates the highest mean in this study. It shows that students engagement with critical thinking dimension is at high level. One of the reasons of this high engagement could be curriculum integration because critical thinking is the most integrated 21st century skill into the objectives. Another reason could be derived from critical thinking skills not only integrated into science curriculum but also other disciplines' curricula, too (MoNE, 2018b, 2018c). Since it is the most integrated 21st century skills into science curriculum, it can be said that, other disciplines also integrated critical thinking skills into their aims and objectives.

Concerning creative thinking skills, previous studies mostly defined creative thinking as a crucial skill that facilitates individuals' learning by using their imagination, provides a confident to express their ideas freely (Ersoy & Başer, 2013). In order to spread the creative thinking skills among the students in the school context, teaching and learning environments and teaching methods should be designed to boost students' creativity. (Ersoy & Başer, 2013). The results of the main study present moderate level of student engagement in this dimension with the mean of 3.53. In the curriculum, it is observed that creative thinking skills are also one of the most integrated 21st century skill into the science curriculum as well as other disciplines, too. Actually, creative thinking is vital for long-term success of individuals and current curricula seem promising that, with the well-prepared objectives translated in the practice, students' high engagement could be promoted more.

Moving on now to authentic problem solving, which is the last dimension in the thinking practices. The main study results demonstrate students' engagement with authentic problem-solving skills are at moderate levels with the mean of 3.48. In the curriculum, it is observed that, authentic problem-solving dimension is effectively integrated into objectives of science curriculum. In the 2018 science curriculum, there are several objectives that requires students to apply their knowledge to solve their daily life problems. For instance, in the 4th grades curriculum students are expected to find solutions to decrease the light pollution (pg.23) and sound pollution (pg.24). There are other objectives that expected students to use their current science knowledge and solve daily life problems and all of these could have resulted students' high engagement. Moreover, in the literature it is seen that students are motivated to solve real-world problems (Lombardi, 2007). With the help of well-designed objectives and using problem-based learning in lessons, the engagement level of these dimension will be higher. On the other hand, there are still significant number of students who are undecided about their authentic problem-solving skills. The reason of this could derived from learning environments. Teacher centred learning environments could not help students to master their authentic problem-solving skills even some objectives try to promote these skills. Maybe the teachers should have informed first about the importance of student centred learning environments in terms of promoting students' 21st century skills. For instance, Singapore government has developed a policy called "Teach Less Learn More" which encourage teachers to create more student-centred learning environments. By this way, education can promote high quality of learning to students and adapting their knowledge into their lives (Cho, Caleon, & Kapur, 2015).

4.1.3. Outcome in 21th century learning

In the instrument, knowledge creation efficacy dimension is accepted as a learning outcome which can be significantly associated with other dimensions. In the literature, knowledge creation has a complex nature because of the students' role in the school (Scardamalia & Bereiter, 1999). The main role of students is learning in the schools. They should learn knowledge about topic, skills that required to be successful in the boundary of national curriculums. It is believed that these knowledges and skills will make them better citizens for economic and global purposes (Tan & Tan, 2014). According to Scardamalia and Bereiter (1999), learning knowledge and skills are crucial and required in order to promote knowledge creation skills of students and promote their knowledge creation efficacy. When the main study results are examined, it is seen that knowledge creation efficacy of students are at moderate levels with the mean on 3.52. Since this dimension is an outcome, when students' perceptions about other dimensions are developed over time, it can be expected that students' knowledge creation efficacy will develop, too. In this sense, when students become advanced in other dimensions, knowledge creation becomes an intentional activity in the classrooms and students will started to see this whole process as a continuum.

5. CONCLUSION AND RECOMMENDATION

Overall, the present study suggests that the Turkish version of the "Students' Perception of 21st Century Learning Practices" instrument can be used as a valid and reliable measure which can be used as a multidimensional, diagnostic tool in Turkish middle school context. According to the results from the main study, in spite of the curricular emphasis on various 21th century skills, integration of these skills to science classes appear to be at moderate levels. In order to improve this integration, curricular objectives can be revised and some of the 21th century skills can be better emphasized guiding the science instruction. In addition, in the future studies, science teachers' perceptions regarding the impeding and facilitating factors for this integration can be explored in detail, and necessary actions can be taken. For example, if it is found that teachers do not perceive themselves as competent enough to implement related strategies, they can be provided with a special training to improve their classroom practices in terms of the emphasis on the 21th century skills. For instance, they can attend training about integrating ICT to their lessons or debate trainings to improve their critical thinking and problem solving skills or STEM trainings in order to improve their creative thinking and problem solving skills. Moreover, because teachers' beliefs, knowledge or skills are translated to their instruction, future studies can also examine the level of science teachers' own 21th century skills as well.

Research and Publication Ethics Statement

This paper is complied with research and publication ethics.

Contribution Rates of Authors to the Article

Ünzile Elif Uğur: Data Collection, Data Analysis, Writing- original draft, Writing –reviewing & editing. Semra Sungur: Conceptualization, Methodology, Data Analysis, Writing –reviewing & editing.

Statement of Interest

There is no conflict of interest to declare.

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7. GENİŞ ÖZET

Dünyada ve ülkemizde yaşanan bilimsel, teknolojik ve sosyokültürel gelişmeler öğrencilerin gelecekte toplumun üretken üyeleri olarak sahip olmaları gereken temel bilgi, beceri ve yeterliliklerin farklılaşmasına sebep olmaktadır. Bu farklılaşma, çağın gerekliliklerini karşılayabilecek bireylerin yetiştirilmesini sağlayacak olan öğretim programlarının (müfredatlarının) yenilenmesi ve güncellenmesi ihtiyacını doğurmaktadır. 2016-1017 Eğitim öğretim yılında yapılan müfredat geliştirme çalışmalarında, öğrencilere kazandırılması hedeflenen temel yeterlilik ve becerilere önem verilmiştir (MONE, 2018a). Yenilenen fen bilimleri dersi öğretim programında, 21.yy. becerileri olarak adlandırılan ve çağın mezunlarının sahip olması beklenilen yeterlilik ve beceriler kazanımların ve/veya kazanım açıklamalarının yapılandırılmasında göz önünde bulundurulmuştur (MONE, 2018a).

Bu çalışmada ortaokul öğrencilerinin sahip oldukları 21. Yüzyıl becerilerini fen bilimleri derslerinde ve günlük hayatlarında ne kadar etkili kullandıklarını belirlemektir. Bu amaç doğrultusunda aşağıdaki sorulara cevap aranmıştır.

Türkçeye uyarlanan "Fen Öğreniminde 21.yy. Becerileri Ölçeği (Chai et al., 2015) geçerlilik ve güvenilirliği ne düzeydedir?
Ortaokul öğrencilerinin fen bilimleri dersinde deneyimledikleri 21. Yüzyıl becerileri ne düzeydedir?

Yukarıdaki amaçlar doğrultusunda ilk olarak Chai, Deng, Koh ve Tsai (2015) tarafından geliştirilen "Fen Öğreniminde 21.yy. Becerileri" ölçeği Türkçeye çevrilmiş olup, fen eğitimi alanında uzman kişiler tarafından içerik geçerliği açısından incelenmiştir. Ölçeğin dil eş değerliğine yönelik olarak Türkçe ve İngilizce okutmanlarının görüşleri alınmıştır. Uzman görüşleri doğrultusunda, bazı maddelerin ifadelerinde değişiklikler yapılmıştır. Sonrasında ölçeğin Türkçe formu, uygun örnekleme yöntemiyle seçilmiş ortaokulda okumakta olan 107 öğrenciden oluşan pilot gruba uygulanmış, geçerlik ve güvenilirliğe yönelik bulgular elde edilmiştir. Bu veriler doğrultusunda ölçekte gerekli düzenlemeler yapılmıştır. Sonrasında ise, 461 ortaokul öğrencisinden oluşan ana gruba uygulanmıştır.

Elde edilen veriler, ilk olarak anketin geçerliliğini ve güvenilirliğini test etmekte kullanılmıştır. Pilot çalışmanın sonuçlarını incelemek için güvenilirlik testi yapılmış olup, alt boyutların güvenilirlikleri .71-.87 aralığında çıkmıştır. Sonrasında ölçeğin geçerliliğini test etmek amacıyla doğrulayıcı faktör analizi yapılmıştır. Sonuçlar kabul edilebilir olmasına rağmen, detaylı incelemeler sonucunda üç maddenin faktör yüklerinin düşük olduğu belirlenmiştir. Özellikle bilişim ve iletişim teknolojileri alt boyutunda bulunan "fen bilimleri dersinde, öğrenmeme yardımcı olacak bilgilere internetten faydalanarak ulaşırım" maddesinin diğer maddelere kıyasla faktör yükünün düşük olduğu görülmüştür. Gerekli olan düzenlemeler yapıldıktan sonra ölçek ana gruba uygulanmıştır. Sonuçlar ölçeğin geçerli ve güvenilir olduğunu ortaya koymuştur. Fakat doğrulayıcı faktör analizi incelendiği zaman pilot çalışmada faktör yükü düşük olan maddenin asıl çalışmada da faktör yükünün düşük olduğu görülmüştür. Fakat içerik geçerliğine katkısından dolayı ölçekte tutulmuştur.

Asıl çalışmanın sonuçları göz önünde bulundurularak öğrencilerin deneyimledikleri 21.yy. becerileri incelendiğinde ise, genel olarak öğrencilerin öğrenme ve düşünme pratiklerini fen öğrenimlerinde kullanmalarının orta seviyede olduğu görülmüştür. Öğrenme pratikleri detaylı olarak incelendiği zaman ilk olarak öğrencilerin öz yönelimli öğrenme boyutuna verdiği cevaplar orta derecede katılımı göstermektedir ve göz ardı edilemeyecek çoğunlukta öğrencinin ise kararsız kaldıkları gözlenmektedir. Orta derecedeki katılımın ve göz ardı edilmemesi gereken kararsız cevapların sebebi öğrenme ortamının öz yönlendirmeli öğrenmeyi desteklemeyecek şekilde düzenlenmiş olması olabilir. İkinci olarak bilişim ve teknoloji ile anlamlı öğrenme boyutu incelendiği zaman, öğrencilerin katılımlarının bir madde haricinde düşük seviyede olduğu gözlemlenmiştir. Bu sonuçların sebeplerinden biri öğrencilerin bilişim ve iletişim teknolojilerini eğitim amaçlı değil, eğlence amaçlı kullanmaları olarak gösterilebilir. Diğer bir sonuç ise öğretmenlerin bu teknolojileri derslerinde, sınıf ortamlarında etkili kullanamamaları olabilir. Üçüncü olarak işbirlikçi öğrenme boyutu incelendiği zaman, öğrencilerin katılımının bir madde dışında orta seviyede olduğu görülmüştür. Bu sonucun sebebi, grup çalışmalarının etkin yapılamaması, öğretmenlerin grup çalışması sırasında sınıf yönetimi konusunda problemler yaşaması olabilir.

Öğrencilerin düşünme pratikleri düşünüldüğü zaman, ilk olarak kritik düşünme boyutu incelendiğinde, öğrencilerin katılımlarının yüksek seviyede olduğu görülmüştür fakat kararsız kalan öğrencilerin sayısı da göz ardı edilemeyecek boyuttadır. Bu yüksek katılımın sebebi fen bilimleri müfredatında kritik düşünmenin birçok kazanıma entegre edilmiş olması olabilir. Ek olarak diğer alanların (matematik, sosyal bilgiler, vb.) müfredatlarında da geçmesi bu yüksek katılıma etkisi olduğu düşünülmektedir. Kararsız kalan öğrencilerin sebebi ise, kritik düşünmenin kompleks yapısından kaynaklanıyor olması gösterilebilir. Kritik düşünme; çıkarım yapma, analiz yapma, sentez yapma, değerlendirme gibi alt boyutları mevcuttur ve öğrencilerden tüm bu yeteneklere sahip olması beklenilir. İkinci olarak yaratıcı düşünme boyutu incelendiğinde ise, öğrencilerin katılımlarının orta seviyede olduğu ve kararsız öğrencilerin sayısının da göz ardı edilemeyecek miktarda olduğu görülmüştür. Kararsız öğrenciler için, sınıf ortamında bu boyuta yapılan vurgu arttırıldığı takdirde katılımın artacağı düşünülmektedir. Üçüncü olarak otantik problem çözme boyutu incelendiğinde ise öğrencilerin katılımlarının yine orta düzeyde olduğu görülmüştür ve kararsız kalan birçok öğrenci de mevcuttur. Bu boyutunun müfredattaki entegrasyonunun yüksek olduğu söylenebilir.

"Fen Öğreniminde 21.yy. Becerileri" ölçeğinde yer alan bir başka alt boyut ise öğrencilerin bilgi üretme yeterliliğini ölçmeye yöneliktir. Öğrencilerin, bu boyuttaki maddeler verdiği yanıtlar incelendiğinde, bilgi fen bilimleri dersinde üretmeye yönelik yeterlik algılarının orta düzeyde olduğu bulunmuştur. Bu durum bilgi üretme yeteneğinin kompleks yapısından kaynaklanıyor olabilir.

Genel olarak sonuçlar, Fen Öğreniminde 21.yy. Becerileri Ölçeğinin Türkçe formunun, ortaokul öğrencilerinin fen bilimleri dersinde deneyimledikleri 21. Yüzyıl becerilerini belirlemek için geçerli ve güvenilir bir ölçme aracı olduğunu göstermiştir. Ayrıca, bu çalışmadan elde edilen veriler, 21. Yüzyıl becerilerinin fen bilimleri derslerindeki entegrasyonunun orta düzeyde olduğunu ortaya koymuştur.