Engineering Design Approach in 21st Century Science Education

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Introduction

In the century we live, in other words in the 21st century, the importance of qualified manpower is increasing day by day. However, the qualities expected from today' individuals are changing every day. Technological and scientific developments play a major role in this situation. Individuals that we will define as qualified people can be considered as individuals who will adapt to what the era brings. The leading countries in technology and science reform their education systems in order to raise qualified individuals who have the ability to adapt to the requirements of the age. The reason for these changes is the scientific and technological developments, to which a new one is added every day, as well as the increasing human population. On the other hand, the interest of all individuals, who live in today's society surrounded by technology, towards technology is increasing day by day. The contribution of technological innovations that are supported by new ideas and useful products to the economy of the country is gradually growing (Dugger, & Gilberti, 2007). This leads societies and individuals to professions related to engineering, science and technology. Therefore, in the 21st century, science, technology, engineering and mathematics disciplines play a key role in solving current and future problems.

21st Century Skills

21st century skills are defined by different institutions and organizations. The Partnership for 21st Century Skills (P21, 2002), established in 2002 with the support of the US Department of Education, is one of them. Its mission is to "Putting 21st century preparation at the center of US K-12 education by establishing cooperative partnerships between education, business, society and top leaders" (Kyllonen, 2012). P21 21st grouped century skills under three main themes: learning and innovation skills; information, media and technology skills; and life and career skills.

P21 also suggested that the outcomes of 21st century student can affect standards and assessment, program and teaching, professional development, and learning settings (Kyllonen, 2012). These skills are defined as the keys unlocking lifelong learning and creative work (Trilling & Fadel, 2009).

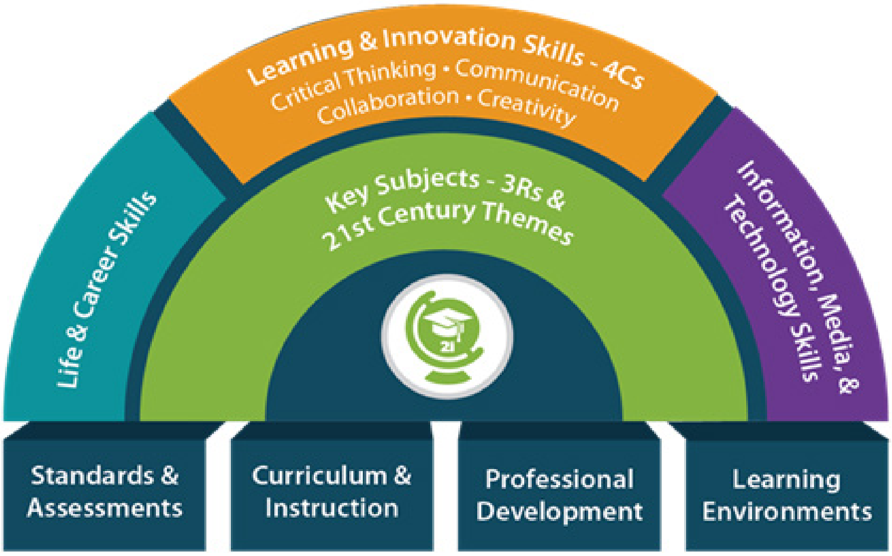

Figure 1. *The 21st Century Knowledge-and-Skills Rainbow (P21).*

Life & Career Skills

Life and career skills include flexibility, entrepreneurship, social skills, productivity, and leadership sub-themes. There is no common definition in the literature for life skills. Life skills are defined as skills that enable individuals to be successful in different environments such as school and home (Danish, Forneris, Hodge, & Heke, 2004). These skills are also defined as adaptation skills that enable individuals to cope with the problems they face in daily life (World Health Organization [WHO], 1997). As can be seen from these definitions, life skills are the skills that are desired to be gained by the individuals for living in the society. These skills are aimed to be acquired by students through education, because the individuals with life and career skills possess various skills including flexibility and harmony in both daily and business life, entrepreneurship and self-direction, productivity, leadership, responsibility, and social and intercultural skills. In this sense, flexibility and adaptability skills that every individual should gain in order to keep up with the new terms of the constantly changing world and to adapt the existing situations to the new situations are considered as indispensable skills (Trilling & Fadel, 2009). In addition, the individuals who have self-regulation capacity, who gained social communication skills, who are open to innovations, and who can take individual and group responsibilities are considered as the individuals who acquired 21st century skills, which describe the profile of the era's desired individual. For this reason, 21st century skills form the skeleton of the skills required for the individuals of our age and the future, to be able to exist in life and in the world. 21st century skills are classified in different ways by different sources. The common skills in these classifications are critical thinking, problem solving, communication, cooperation, effective use of technology, creativity, innovation, and entrepreneurship (Beers, 2011).

Entrepreneurship is the skill that stands out among life and career skills. Although entrepreneurship seems to be a very new term, the history of this concept is very old. The concept of entrepreneurship was first used economically (Curth, 2011). This concept, which has gained importance in recent years, has reached its scope after 80's. There is no common definition for entrepreneurs and entrepreneurship accepted by everyone. Entrepreneurship is a kind of behavior that represents a combination of risk, creativity, personal success and innovation, focused on opportunities and economic resources, and also adopts financial, moral and social responsibility to create a new and profitable business idea that can contribute to solving social problems (de Lourdes Cárcamo-Solís , 2017).

The need for manpower, which has been increased with the advancements in science and technology, requires individuals to benefit from existing opportunities and express new business ideas. Providing students with entrepreneurial features should be included in school guidelines for the benefit of school and society (Adeyemo, 2009). From this point of view, science teachers play an important role in gaining entrepreneurship to students. In the science curriculum implemented in Turkey, students are first expected to identify a problem encountered in daily life, create a product and develop their engineering design skills, then to develop their entrepreneurship skills by creating marketing strategies for the product and using promotion tools (MEB, 2018).

Learning & Innovation Skills

Meeting the demands of the 21st century world, helping to build a better world, creating new knowledge and innovations are always at the center of learning and innovation skills. Learning and innovation skills consist of three sub-themes, namely critical thinking and problem solving, communication and cooperation, creativity and innovation (Trilling & Fadel, 2009).

Critical thinking, which is one of the learning and innovation skills, is a high-level thinking skill consisting of various processes such as reasoning, applying, analyzing, evaluating and creating (Hughes, 2014). Critical thinking is the mental processes that people use when solving problems, making decisions and learning new concepts (Sternberg, 1986). In critical thinking the knowledge is not used as learned, new knowledge is combined with previous knowledge, which improves learning outcomes. Critical thinking is the skill that allows problem solving by using knowledge and arguments. Considering these features of critical thinking, it can be concluded that it is related to 21st century skills. Problem solving is the ability to deal constructively with the problems we face (WHO, 1997). Problem solving is often the knowledge and skills required to effectively deal with complex situations (Funke, Fischer, & Holt, 2018). Critical thinking and problem solving is the process of developing solutions using knowledge and arguments. These skills are integrated with 21st century skills.

Another skill included in the learning and innovation skills is communication and collaboration. Communication has been defined as expressing emotions, thoughts and ideas by effectively using verbal and non-verbal communication types with different methods and under different conditions (Trilling & Fadel, 2009). Communication cannot be considered apart from education because all learning and teaching activities are intertwined with communication. The social skills of the people who are successful in communication are also strong and they are also successful in teamwork, respectful to listening and thinking, sensitive and open to sharing. Cooperation, on the other hand, can be defined as the partnership that individuals create in line with their benefits and interests. In short, new ideas arising from personal differences lead to creativity and innovation.

Regarding the time period from past to present, imagination and creativity played an important role in the development of science and technology. Creativity, which play an important role on scientists' work, is defined as the process of producing new ideas and products (Isbell & Raines, 2003) using the acquired knowledge and skills. Creativity and innovation, which are among the learning and innovation skills, constitute learning environments that encourage inquiry, openness to new ideas, self-confidence and learning from errors and failures (Trilling & Fadel, 2009). Individuals who have creativity skill are expected to be productive, innovative, to produce comprehensive ideas and to have high-level thinking skills. These individuals are open to innovations, they are not stuck in stereotypes.

Information, Media, & Technology Skills

Information, media and technology skills include information literacy, media literacy, ICT (Information, Communication and Technology) literacy. The individuals who have information literacy, media literacy and ICT literacy skills are thought to be able to acquire 21st century technology skills. In this sense, the concept of literacy should be perceived as having the skills that people can continue their lives by working in a technological world and being able to acquire technology-based skills (Panel, 2002).

The prominent 21st century skills such as adaptation, entrepreneurship, productivity, creativity, innovation, critical thinking, problem solving, communication, collaboration, information, media and technologies are also among the skills that are effective in STEM education and engineering design process. These skills required for life and work are considered to be related to STEM integration and engineering design process to produce target and need-oriented new knowledge, new services and new products, briefly for discoveries and inventions.

Science, Technology, Engineering and Mathematics Education (STEM)

With globalization, the leadership race between countries is increasing rapidly every day in many fields such as health, technology, science, art and industry. The competition of the countries in all these fields requires that they do not fall behind in the areas such as technology and science. In order not to be the last in this race, countries have reformed their education policies. STEM, which is an interdisciplinary approach in raising individuals who will reflect the change, is included in the educational objectives of many countries. Many countries, especially United States (USA), Japan, Korea, China, have started STEM practices in education to create an innovative society. In many countries, the inclusion of these applications that are based on the integration of these four disciplines in the education program necessitates to make reforms in teacher training education, which plays a key role in the training of future architects.

Although the concept of STEM emerged in the late 19th century, its foundations go back much earlier (Ostler, 2012). It was first used by Judith A. Ramaley in the 1990s (Bybee, 2013; Sanders, 2009). In the literature, there is no common definition about STEM. The National Research Council (1996) defined STEM as a teaching and learning approach. Lantz (2009) stated that these four disciplines are expressed as a meta-discipline and it is a body in which these disciplines are integrated. Gillies (2015) categorized STEM in two dimensions: education and business. Here, the dimension of education is formed by the fields of science and mathematics, whereas the dimension of business is formed by engineering, technology, career, and economic growth.

STEM education can be expressed as the understanding of the world we live in by the integration of the subjects across science, technology, engineering and mathematics disciplines (Dugger 2010). In addition, compared to the traditional education approach STEM education is an approach mostly based on research, project, student-centered and collaborative learning (Breiner, Johnson, Harkness, & Koehler, 2012; Israel, Maynard, & Willamson, 2013).

STEM education has been implemented at all levels of education in many countries such as USA, European Union countries, Japan, Korea, Germany and China. STEM education aims to increase students' orientation towards STEM fields at the university and to provide solutions to the problems they encounter in daily life based on science, mathematics, engineering and technology knowledge (Thomasian, 2011). In addition, STEM education aims to improve students' ability to compete in the economy and develop STEM literacy (Ejiwale, 2013). The training of individuals who are competent in the field of STEM, STEM literate and adapted to the professions of the future is important for the development of the national economy.

Engineering Design Process

The integration of all disciplines included in STEM education approach is not possible due to the current structure of schools and education programs (Bybee, 2010; NRC, 2012). Therefore, it seems likely to implement STEM activities by integrating technology and engineering into the curriculum of science and mathematics courses (Bybee, 2010). Another integration is to provide engineering education by integrating engineering into science, technology and mathematics through appropriate activities. The most appropriate way to achieve this is to carry out the activities within the scope of the engineering design process (Felix, Bandstra, & Strosnider, 2010). The engineering process is defined as making the knowledge suitable for others by using it to create new things (Brophy, Klein, Portsmore & Rogers, 2008). Designs are the way that engineers use to solve engineering problems. Design is considered as a recurring process carried out within predetermined constraints to develop products or systems meeting human needs and desires. Design typically includes components such as problem definition, data analysis, modeling, and solution development, and can have both technological and social components (Daugherty, 2012).

Steps of the Design Process

The engineering design process is more than an applied science and includes a recurring process to turn problems into solutions (NGSS Lead States, 2013). Engineering design process is a problem-solving method that uses the knowledge coming from different disciplines to produce a solution for the described problem through a non-linear process. This process is carried out by using the knowledge coming from many fields, including mathematics and science, in a cyclic process to produce solutions for technological problems, thus creating and developing solutions that answer the problem or need.

Regarding the steps of the design process, different cycles were created by the researchers. Tayal (2013) specified the steps in this process as identifying the problem, conducting research, determining the needs, selecting solutions, development, constructing the prototype, test and redesign. These steps are similar to those of Hynes et al., (2011) and Mangold & Robinson, (2013).

On the other hand, there are also researchers who express these steps shortly (Brunsell, 2012; NRC, 2012; Wendell et al, 2010). In the classification of Mentzer (2011), these steps are defined as identifying the problem, solutions, analysis/modeling, experimenting, decision making, and teamwork. In a program developed for elementary school students (Engineering is Elementary [EiE], 2013), these steps were described as “ask, imagine, plan, create, develop” cycle. The review of the studies revealed the differences in terms of suitability for student level and staging.

All these processes have common steps such as the identification of the problem, revealing possible solutions, analyzing and evaluating the solutions, and redesigning if necessary (Brunsel, 2012). In the studies involving the steps of the design process, the most comprehensive staging was performed by Hynes, et al. (2011). They used an engineering design process that includes various steps such as identifying the problem, developing solutions, constructing a prototype, evaluating the solution, redesigning, and completing the decision (Figure 1.).

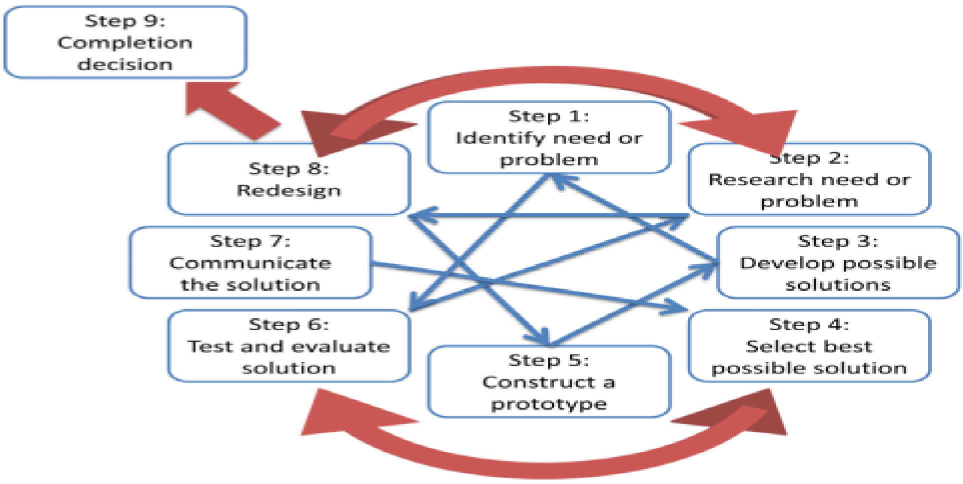

Figure 1. Engineering Design Process (Hynes et al., 2011)

Identifying the Problem: It is seen as the first and most important step of the design process. At this stage, engineers try to identify the criteria and restrictions of the product or need through questions to better define the problem (Brunsell, 2012). In educational process, this step enables students to use their critical thinking skills and to handle identified problems.

Specifying the Needs for the Problem: It is the stage where the students discover that there are alternative solutions instead of solving the problem with the first obvious solution. In this step, students start to analyze the need or the problem and redefine it accordingly. Thus, it will be possible to discover new paths and prepare the ground for the successful continuation of the process on these new paths.

Developing Possible Solutions: At this stage, brainstorming takes place to produce multiple solutions, thus contributing to the creativity of the students. This step is also considered as the stage where the creativity of students is at the maximum level (Hynes et al., 2011).

Choosing the Best Solution: This stage involves the selection of the most suitable solution by evaluating the ideas discovered by the students in problem identification and research stages, in accordance with the criteria and restrictions.

Construction of a Prototype: The prototype can be defined as a representation or physical model of the decided solution. It can also be a virtual or mathematical model (Hynes et al., 2011). At this stage, individuals design prototypes to visualize, present, and show the details of their solution and improve the design (Tayal, 2013).

Testing and Evaluating the Solution: At this stage, students perform testing operations according to the specified criteria and restrictions in order to evaluate whether their prototypes are successful. In this way, they find out the methods and tools that can define the requirements well. However, if necessary, they can go back to the identification of the needs stage and handle the process more confidently.

Presenting the Solution: At this stage of the engineering design process, the ideas and findings about the solutions are shared with the others for feedback. Solutions can be shown through written documents or presentations, which include performances, topics, limitations and restrictions (Hynes et al., 2011). At this stage students have also the opportunity to revise their works based on the feedback given at the end of the presentation.

Redesign/Revision: At this stage, the strengths and weaknesses of the design are identified after presenting the solution. It is the stage where prototype development, tests and evaluations continue until a final product that meets all requirements and criteria is produced.

Completion of the Decision: It is the stage when students decide that the design needs are sufficiently satisfied and they are ready to implement their prototypes as the final product (Gentilli et al., 1999).

Design Based Science Education

These steps of engineering education have been used in science education in recent years, especially with the inclusion of STEM education into the curriculums. The integration of science education with other disciplines (mathematics, engineering and technology) is carried out based on engineering design problems (Wendell et al, 2010). The realization of the learning in science education through engineering design problems is named as design-based science education in the literature (Mehalik, Doppelt, & Schunn, 2008; Wendell et al, 2010). De Vries (1996) suggested that students should be helped to integrate the knowledge they have acquired into their design processes.

One objective of design-based learning (DBL) is providing students with a variety of opportunities to integrate what they have learned in the classroom into real life situations (Ryan, Camp, & Crismond, 2001). First, it motivates students to learn by applying their knowledge into real life situations, since a good design should meet existing and real needs (Doppelt, 2003). Second, design-based learning has all the features of active learning since it is active (Doppelt, Mehalik, Schunn, Silk, & Krysinski, 2008). Third, design-based learning is typically a team activity and therefore includes the characteristics of cooperative learning. A learning environment that allows cooperative learning also improves students' communication and problem-solving skills (Doppelt, 2004; 2006). Design-based learning is a versatile process that motivates learning, supports active and collaborative learning, and improves students' communication and problem-solving skills. Many US teachers lack design skills (Ritz & Reed, 2006) and this is not very different in Turkey. Thus, before developing students' design skills, a large number of works are needed to improve the design skills of teachers.

Literature Review

21st Century Skills

In the literature, there are studies related to 21st century skills conducted with teachers, students and academicians. In a study by Shidiq and Yamtinah (2019), teachers have shown positive attitude towards 21st century skills, but their working approach lacked communication and collaboration skills. In the study aiming to identify the methods implemented in the curriculums to give 21st century skills to the students, Sweet (2014) found that project-based method is the most used teaching method. Dibenedetto (2015) investigated the professional competencies of teachers for the skills and attitudes that high school students need for specifying their careers in the 21st century. This study revealed that career and technical education teachers have a higher perception level and sense of responsibility than other teachers.

The study conducted by Amran, Perkasa, Satriawan, Jasin, & Irwansyah (2019), showed that students' 21st century attitude (critical thinking, cooperation, communication and creative thinking) can be categorized as low, whereas their environmental awareness can be categorized as sufficient. The learning model that teachers use in teaching was considered as the reason of students' low skill level and it was thought that this could be prevented by designing a course for improving 21st century skills. In addition, there is a study in the literature examining undergraduate students' entrepreneurship experiences, which is one of the 21st century skills (Ghafar, 2020). In this study, the themes such as 21st century skills, creativity, leadership, entrepreneurial values, experiential learning and entrepreneurial education were used to develop an interview guide. At the end of the study, the entrepreneurship training was observed to develop some 21st century skills such as social relations, leadership, creativity and critical thinking, and in this case, it was observed to further strengthen students' entrepreneurial intentions. Hence, this study revealed that entrepreneurship training offers various ways to further improve the integration of 21st century skills.

Boe (2013) applied the 21st century skills inventory to the students and academicians at the university and reported that; participants agreed that technology skills should be used as a tool, they adapted them without much difference, and students showed more participation in critical thinking and self-control skills (Boe, 2013).

STEM Education

Regarding the studies about STEM, there are studies conducted with teachers, preservice teachers and students. In the study by Geng Jong and Chai (2019), it was concluded that teachers do not find themselves ready for STEM and they have concerns about "knowledge", "management" and "outcome" regarding the implementation of STEM education in schools. Jho, Hong and Song (2016) examined the achievement conditions for STEM teacher education and practice. As a result of this study, it was found that for teachers to gain competence for STEM education a free working environment should be created and common goals should be set through interdisciplinary studies. Pinnell, et al. (2013) conducted workshops and activities about the effects of STEM education on the knowledge and skills of teachers and preservice teachers. During the trainings, they worked with a faculty member from the engineering faculty, an engineer working in the industry and an engineer candidate studying at the engineering faculty. As a result of the research, design and engineering-based STEM education practices were found to improve leadership skills and perceptions about teaching competencies.

In their study Siverling and Suazo-Flores (2019) concluded that while students justify their engineering design ideas and solutions in engineering design-based STEM integration units, they integrate the content from all four STEM disciplines and thus support engineering design-based STEM integration as a curriculum model. Saleh (2016) investigated the effect of STEM education on students' problem-solving skills levels and attitudes towards STEM education. In the study, a STEM program was designed and applied to students. As a result of the study, it was concluded that STEM education increased students' problem-solving skills and attitudes. Brown, Concannon, Marx, Donaldson and Black (2016) analyzed STEM approach-based teaching according to various variables. As a result of the research, significant differences were found between the gender and beliefs, perceptions and interest towards STEM. Dass (2015) examined the effects of STEM practices and full learning on students. In addition, he analyzed students' attitude towards STEM, interest in science, inquisitive thinking skills, and the change of academic achievement. As a result of the research, STEM applications and full learning were found to have a positive effect on interest in science and academic achievement. However, he concluded that STEM practices and full learning had no effect on the attitude towards STEM and the development of inquisitive thinking skills towards science.

Another study with preservice teachers (Ring, 2017) has investigated how the concepts about STEM education integrated into the lessons of pre-service teachers are effective in the implementation of STEM programs.

Unlike other studies, Hasanah and Tsutaoka (2019) aimed to identify and classify the barriers in front of the Science, Technology, Engineering and Mathematics (STEM) Education worldwide. In STEM education, the intrinsic barrier arises from the personality of the teacher and the student, while the extrinsic barrier mainly arises from the inadequate and/or improper arrangement of the infrastructure. Institutional barriers are concluded to be the curriculum, policy, technology and organizational feeding in the field of education.

Design Based Learning (DBL)

Some researchers have noted the advantages of design-based learning (DBL) as a tool to increase motivation, develop high-level cognitive skills and develop personal and interpersonal traits (Doppelt, 2003). There are many studies showing interesting findings regarding the advantages of DBL.

There are various studies in the literature on the decision making and problem-solving skills of design-based learning (Fortus, Krajcik, Dershimer, Marx, & Mamlok-Naaman, 2005). Moreover, there are studies in the literature that examine the relationship between perception towards problem-solving skills and decision-making attitudes, which are considered important in the design process (Seckin-Kapucu & Karakaya-Ozyer, 2019). There are also many experimental studies in the literature that examine the effect of design-based learning on students' academic achievement in science education (Doppelt, 2003; Doppelt, Mehalik, Schunn, Silk & Krysinski, 2008; Mehalik, Doppelt, & Schunn, 2008; Schnittka & Bell, 2011).

The studies conducted with students have shown that they can successfully participate in engineering design (Wendel, 2011). King and English (2016) tried to encourage students for engineering applications by combining real-life problems with engineering design applications. There are many studies in which students experienced engineering design applications and developed products as a result of these experiences (Lamb, Akmal, & Petrie, 2015; Wendell & Rogers, 2013).

There are many studies in which the engineering design process is integrated into science courses (Apedoe et al., 2008; Schnittka & Bell, 2011). In their study, Schnittka and Bell (2011) performed engineering design activities involving heat transfer and thermal energy subjects with secondary school students. In their research, Apedoe et al. (2008) used the engineering design process in the eight-week Warming-Cooling Systems unit in order to create a guide that combines design-based learning with science subjects, to teach difficult chemistry concepts and to increase interest in engineering career. Roth (2001) combined the design activities that students will carry out on simple machines subject with engineering applications and identified the product design stages to be carried out.

There are also studies in which engineering design process is integrated into science education, focusing on design development with students (Sadler, Coyle, & Schwartz, 2000; Ellefson, Brinker, Vernacchio, & Schunn, 2008). In their study, Sadler, Coyle and Schwartz (2000) asked students to improve the prototypes offered to them. Ellefson, Brinker, Vernacchio and Schunn (2008) used design-based learning to teach the topic of "gene transfer" in their research.

The review of the studies conducted with teachers showed that they attempted to improve teachers' understanding of engineering design process (Felix, Bandstra, & Strosnider, 2010; Hynes, 2012), the opinions of science teachers about engineering applications were collected in science lessons (Capobianco, 2011; Cuijick, et al., 2009), and teachers' perceptions towards engineering education were identified (Hsu et al., 2011)

Regarding the studies conducted with preservice teachers, they mostly provided vocational training on engineering design process (Dailey et al., 2018) and aimed to reveal what they learned about engineering design-based science teaching (Culver, 2012). The trainings about engineering applications to be given to teachers and preservice teachers in-service or during undergraduate programs are important for better implementation of the engineering process in schools and for the students to acquire the skills required in the engineering design process. Further studies should be conducted after giving these trainings to the teachers and preservice teachers.

Conclusion

Rapidly changing world conditions brought some skills required to support individuals' success in daily and business life. In our age, these skills stand out as 21st century skills. 21st century skills put the school courses to the core and build life and career skills, learning and innovation skills, and information, media and technology skills on them (Trilling & Fadel, 2009). The sub-skills of these 21st century skills include entrepreneurship, productivity, responsibility, creativity, innovation, critical thinking and problem solving, communication, cooperation, and technology literacy skills. These skills are among the skills that are effective in STEM education and engineering design process.

STEM which has emerged in the United States (USA) in 1990, has been implemented in many countries. STEM is included in the education systems of many countries in the world that care about technology and aim to progress in innovation. STEM acts as a bridge in the passage of the children, who will build the future, from education to business (Gomez & Albrecht, 2014).

STEM was defined as a teaching and learning approach that integrates the content and skills included in science, technology, engineering and mathematics disciplines (NRC, 1996). Compared to traditional education approaches, this approach appears as an active process that pushes students to research, solving problems by combining them with daily life, decision making, critical thinking, taking responsibility, and project-based learning. The objective of the integration of the disciplines mentioned in this approach is that students understand the world we live in. Another objective is to gain the ability to make products that will provide economic development through the competence in STEM fields. Engineering is one of the areas that will ensure this. STEM education can be provided by integrating engineering into science, technology and mathematics fields through appropriate activities. The most effective way of this integration is to handle the activities within the scope of the engineering design process. Design is the process where engineers solve engineering problems. The design process is similar to problem-solving and includes identifying the problem and specifying the need, collecting information, bringing alternative solutions to the problem, selecting the most appropriate solution, designing and creating a prototype, and evaluation stages (Doppelt, et al., 2008).

The field-specific skills mentioned in science curriculum implemented in Turkey and updated in 2018, include life skills and engineering design skills. Life skills include basic skills that individuals need in their daily lives (analytical thinking, decision-making, creative thinking, entrepreneurship, communication and teamwork). Engineering and design skills include innovative thinking skills that enable students to create a new product by making inventions and innovations. At the same time, engineering practices are integrated into all grade of the science curriculum starting from the 4th grade.

Engineering design skills are considered as a product creation process by integrating science, mathematics, technology and engineering disciplines, and using individuals' knowledge and skills from an interdisciplinary perspective. In order to reach knowledge in this process, life skills such as decision making, entrepreneurship and teamwork should be gained. Depending on the acquisition of these skills, a purposeful product is created. On the other hand, it is seen that entrepreneurship become a part of the efforts when a value can be assigned to the created products by developing strategies.

The inclusion of engineering in the K-12 Science Education and Next Generation Science Standards Framework (NGSS) creates new requirements for science teacher education (National Research Council [NRC], 2012). On the other hand, very few teachers can experience engineering or "engineering design" in their schools, and many afraid of transfering these processes to their students, especially at primary school level (Cunningham & Carlsen, 2014).

Teachers are expected to direct their students to product development, invention and innovation by considering their potential as well. However, the review of the teacher training programs in our country revealed that there is no course for teaching 21st century skills such as STEM, engineering practices, entrepreneurship, life skills. In this sense, training programs should be strengthened in order to gain the mentioned skills, and the necessary trainings on how these skills can be given to students should be provided to both teachers and preservice teachers. Accordingly, efficiency will be be ensured in education and at the same time the individuals who may meet the needs of the country and the economy can be raised. At the same time, it is thought that this may contribute to the future generations and will provide a basis for them to take part in the education system that has a strong infrastructure. In this way, it is envisaged that well-supported individuals, both individually and socially, can be trained for today and the future.

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