STEM Skills in the 21st Century Education

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Introduction

STEM education, as one of the most striking educational movements in recent years (Kuenzi, 2008; Reiss & Holmen, 2007; Sanders, 2009), is an interdisciplinary field of study linking science, technology, engineering, and mathematics (National Governors' Association, 2007).

Mobley (2015) describes STEM education as "an educational approach in which interdisciplinary applications are made to solve problems in real life and links to different disciplines are created". STEM education emerges as an interdisciplinary concept involving teaching science, technology, engineering, and mathematics under one roof. STEM education provides a positive contribution to students' basic skills (problem solving, critical thinking, etc.) by creating interdisciplinary study opportunities (Australian Education Council, 2015). In addition to supporting development of 21st century skills such as STEM literacy, problem solving, critical thinking and creativity (Australian Education Council, 2015; Bybee, 2010; Innovation America Task Force, 2007; Morrison, 2006), STEM education emphasizes three fundamental elements (problem solving, innovation, and design) that have a significant place on every countries' agenda (Hernandez et al., 2014).

STEM education is a learning and teaching approach that integrates science, technology, engineering and mathematics knowledge and skills (Maryland, 2012). STEM education is aimed at the development of students' research-questioning, logical reasoning, and working behaviors in a collaboration. In this respect, the aim of STEM education is to train qualified individuals to meet the 21st century workforce needs (Moore, 2009). With the STEM education, it is aimed that students will work to find solutions to complex problems and global problems and to improve their real life situations (Breiner, Harkness, Johnson, & Koehler, 2012; Sanders, 2009; Wang, Moore, Roehrig, & Park, 2011).

21st Century Skills

The 21st century skills have great importance for a successful school and business life (Washer, 2007). Because transferring the courses in the education programs to the students is necessary for academic success but it is not enough to make a difference in the 21st century we are in (Jerald, 2009). In this context, education is being regulated in order to meet the needs of workforce in industry and economy-oriented occupational fields (Bingimlas, 2009; Gooderham, 2014; Hudson, 2001). It is aimed to educate the individuals who can respond to the needs of the 21st century with these regulations made in the field of education. Thus, interdisciplinary education programs are offered as an alternative to traditional education for the development of 21st century skills (Davies & Ryan, 2011).

One of the aims of STEM education is to develop individuals' 21st century skills (Bybee, 2010). These skills are expressed by NAS (2014) as "providing a meaningful and deep understanding and transfer of knowledge among disciplines". In the 21st century education, the importance of realizing interdisciplinary, personalized, inclusive, flexible, collaborative, student-centered, engaging and exciting teaching environment has been expressed by Cookson (2009) as follows. In providing quality education, global competitive environment, classes and schools must be structured towards 21st century skills and knowledge and skills must be integrated and implemented by educators.

Our world is rapidly evolving in terms of technology and knowledge, and students need to develop the skills they need to be in the changing world (Darling-Hammond, 2010; Friedman 2005; Wagner, 2008). Education is increasing its importance every day in terms of adaptation to changing world and economic competitiveness. Moore (2009) states that in the 21st century, with the changing educational insight, the targeted skills to be acquired by the students must change as well. While students are aiming to compete in a global economy, education and skills at the K-12 level need to be aligned to this goal (Darling-Hammond 2010; Friedman, 2005; Wagner, 2008). For this purpose, curriculum, content, and evaluations should be adapted to student skills and needs and focused on 21st century skills (Friedman, 2005).

Jukes & Macdonald (2007) suggest that 21st century skills must be understood by teachers and taught to students with an effective teaching style. In an effective 21st century education, it is aimed to acquire basic skills such as reading, speaking, and writing as well as social, academic, and engineering skills (Jukes & Macdonald, 2007).

In this context, Jerald (2009) describes the skills that individuals should have in the 21st century society; basic knowledge and skills (academic knowledge and skills), literacy skills (ability to apply academic knowledge and skills in real life) and 21st century skills (ability to use literacy and other skills at any time to succeed in different areas of life).

Today, many sectors expect individuals to have the skills appropriate for the needs of the age, such as problem solving, creative thinking, high communication skills, being open to collaboration, having responsibility, etc. (Eryılmaz & Uluyol, 2015). 21st century skills helps students to easily adapt to the new situation while they are being taught the new knowledge (Dede, 2010). Along with these skills, students are able to adapt to the ever-changing and evolving global community (Pearson, 2014).

When the literature is examined, there is no consensus on what the 21st century skills are (Sahin, Ayar, & Adıgüzel, 2014). However, various institutions and researchers are conducting extensive researches to explain these skills. One of the most important work undertaken in this regard was the Partnership for 21st Century Skills. Partnership for 21st Century Skills (2011) explain the 21st century skills as follows:

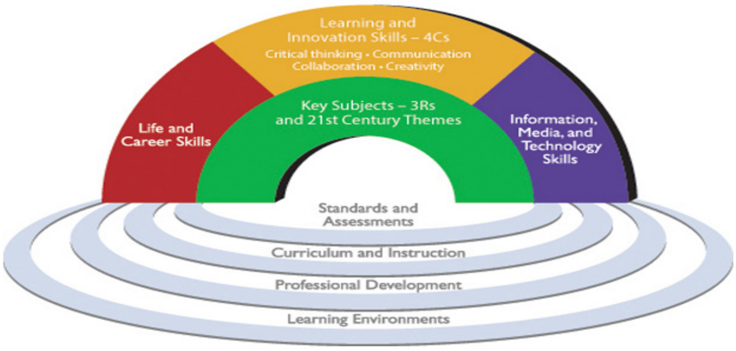

Figure 1. Partnership for 21st Century Skills

Fundamental Issues & 21st Century Themes: Basic topics include fields such as reading, science, mathematics, language, history, and economics. It is aimed to transfer knowledge to solve social problems such as global awareness, finance, economy, environment and health, which are more complex in the academic sense, by associating these basic fields with each other.

Learning and Innovation Skills: With the school and non-school experiences, it is aimed to ensure that students are in an effective learning process. In addition to giving the knowledge to students, awareness should be raised in self-development and innovation in the changing world.

- Critical Thinking and Problem Solving Ability: Critical thinking involves effectively analyzing and evaluating assertions, evidence, and beliefs.

In the 21st century, problem solving skills are effective in helping individuals solve unconventional situations with effective methods.

- Communication: The individual must express his/her ideas in various contexts by using verbal or written communication tools effectively. Effective communication skills gain importance in this direction.

- Collaboration: Individuals need to be able to work in a respectful manner with different teams in the educational environment and business life. With the collaborative education practices, students should be immersed in collaboration.
- Creativity and Innovation: The ability to produce a broad idea to create new and useful ideas.

Knowledge, Media and Technology Skills: The skills that individuals should have in the 21st century are (i) access to a wealth of information, (ii) adaptation to rapid changes in technologic tools, and (iii) contributing by working individually and in collaboration.

- Knowledge Literacy: Accessing and evaluating knowledge critically and competently, managing the flow of knowledge from various sources.
- Media Literacy: Understand how and why media messages are created; understanding and using the most appropriate media creation tools and features to bring media products to the market.
- ICT (Information and Communication Technologies) literacy: Using technological tools as a means of researching, organizing, evaluating and transmitting information.
- Life and Career Skills: In today's global competition, students need to be careful to improve their life and career skills in highly competitive life and work environments.
- Social and Intercultural Skills: Students need to have content knowledge, social and emotional competencies in order to be able to take place in real life and in future working environment.

K-(4-8) STEM Skills in Turkey

In Turkey's Middle School Mathematics Course (5, 6, 7 and 8. Classes) Curriculum (2013), the targeted basic skills were determined as problem solving, mathematical process skills (communication, reasoning, and association), sensual skills, psychomotor skills, and information and communication technologies. In the updated Mathematics Curriculum (MoNE, 2018a), mathematical skills have been included as mathematical competencies. Mathematical competencies include the ability and desire to use mathematical modes of mathematical thinking (logical and spatial thinking) and presentation (formulas, models, fictions, graphics and tables) at different levels.

In the Science Curriculum (MoNE, 2018b), specific skills in the field were categorized as scientific process skills, life skills, and engineering and design skills. Scientific process skills include observing, classifying, recording data, constructing hypotheses, using and modeling data, changing and controlling variables, experimenting. Life skills include analytical thinking, decision-making, creativity, entrepreneurship, communication and teamwork skills related to access to and use of scientific knowledge. Engineering and design skills in the curriculum include strategies on how students can create products and how they can add value to these products using the knowledge and skills they acquire by integrating science, mathematics, technology and engineering and bringing students to the level of being able to make innovations with an interdisciplinary approach to the problems.

Objectives of the 7th and 8th grade Technology and Design Teaching Program (MoNE, 2018c) are to raise individuals who are able to observe and interpret the objects, events and phenomena around in an analytical way, to identify the problems and develop creative and original alternative suggestions, and make evaluations of these suggestions and make decisions for the best suggestion. At the same time, it is aimed to raise individuals who observe, examine, sensitive to environment, feel responsible about the problems that affect human life, propose innovative and original solutions to these problems by using analytical thinking system, have self-confidence, and have skills to work in collaboration.

In this study, it was aimed to examine the skills that are aimed to be taught in science, mathematics, technology and design courses for the 4-8 classes prepared by the Ministry of National Education and the 21st century skills defined by Partnership for 21st Century Skills (2011) and to define the STEM skills within the scope of STEM education. Identification of STEM skills is aimed at identifying the specific skills of STEM training.

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STEM SKILLS

When the literature is examined, it is seen that some skills are accepted as STEM skills and there is a common understanding. These skills are emerging in the form of Engineering Based Problem Solving Skill, Association Skill, Engineering Based Design Skills, Innovation, Digital Competence, Creativity, and Communication and Collaboration.

Engineering Based Problem Solving Skill

In STEM education, problem-solving skills are effective in engineering processes that involve planning, designing, constructing, and evaluating for a specific problem (Bagiati

& Evangelou, 2016; English & King, 2015). Problem solving processes in students' engineering work are described as follows (English, King, & Smeed, 2017; Lucas, Claxton, & Hanson, 2014):

- Identify the problem situation,
- Produce possible solutions for the problem and to evaluate the solutions to meet the problem,
- Test the possible solutions and solve the problem.

During the STEM activities, the students are "learning while doing design" by testing and checking their products during the engineering process brought to the problem solving stage (Crismond & Adams, 2012). STEM education provides a rich content for engineering-based innovative and creative problem solving (Bagiati & Evangelou, 2016; English, 2016). English, King, and Smeed (2017) describe the following steps for problem solving in STEM education:

1. Determining and Identifying the Problem Situation: In determining the problem situation, which is the most basic stage of the design process, the problem situation is extensively addressed and the limitations and targets are determined (Atman et al., 2014; Watkins et al., 2014). Since real-life problems in STEM activities are complex, determining these problems and defining their limitations is effective in constructing problem solutions (Jonassen, Strobel, & Lee, 2006). The problem situation is an important step because it affects the process of designing and delivering products (Atman et al., 2008). Determining the problem situation is an essential step in the design model and specifies the choice of material to be used for the product that will help in solving the problem (English, King, & Smeed, 2017).

2. Product Development for Problem Solving: In order to solve the problem in STEM education, the product is introduced to the market. For this purpose, the stages of planning, preparing, designing, evaluating, redesigning and producing products are included (Portsmore et al., 2012). At this stage, students convey their thoughts about their products in different representations via verbal, written, visual or 3D modeling (English & King, 2015). Drawing skills of students in designing by drawing, computer and modeling program skills of students in 3D models, and communication skills of students in expressing thoughts are effective (Postmore et al., 2012).

3. Product Evaluation and Configuration: The product evaluation phase is important to develop in-depth understanding of the problem (Mehalik, Doppelt, & Schun, 2008). Kendall (2018) states that product evaluation encourages students

in identifying, correcting, and improving the inadequacies of their products. Students try to identify the causes and shortcomings of the their products and improve them. Students have the ability to design and produce product based on academic knowledge of STEM disciplines in problem solving (Watkins et al., 2014; Katehi, Pearson, & Feder, 2009). In this respect, the students' failure to deliver the product may be related to academic knowledge and skills.

Skills for Establishing Relevance

With STEM education, it is aimed to teach students to relate science, technology, mathematics, and engineering within themselves, with other disciplines, and real life; therefore, learning will be meaningful. Through within disciplines, interdisciplinary, and real life relations, instructional content is related to the way it is practiced and makes it meaningful. The types of relations identified within the scope of the study are presented below.

Relating Existing Knowledge with New Knowledge: Piaget (1977) expresses learning as a structure that is improved and organized form of existing scheme by the experiences acquired through the senses. Pound (1977) states that the beginning of the meaningful teaching is the preliminary knowledge of the students and that the relation with the newly learned knowledge should be established. In this direction, it is necessary for students to make connections between the existing knowledge of students in the disciplines of science, mathematics, technology and engineering, and the knowledge they newly learn about these disciplines.

Relating STEM Disciplines within Themselves: In order to establish links between STEM disciplines, prior knowledge and needs of students for each discipline need to be identified and addressed. It is also aimed at establishing links between disciplines as well as the necessity of establishing links between prior knowledge and new experiences in the realization of the teaching.

By relating STEM disciplines within themselves, students are able to understand the relationships and benefits among these disciplines rather than thinking that disciplines include a range of disjointed and isolated concepts and skills. In this way, students can be aware of the relationships for each discipline.

Students can relate at any stage of education. While students in kindergarten relate the new knowledge with the experiences they have outside the school, the students at each level of the elementary education relate the new knowledge with the ones learned in previous stage and the daily life. In the upper levels of education, this relation can be improved as abstraction and generalization. Through this relation, students can realize that each STEM discipline is connected and related.

Relation Between STEM Disciplines: In STEM education and its applications, it is also aimed to enable students to relate disciplines with each other as well as students' relations for each of science, technology, engineering, and mathematics. In this way, how the disciplines are located in each other, its importance, and its effect are recognized.

Relating STEM Disciplines with Different Disciplines: STEM disciplines can be related with many fields such as art, language, history, and geography. Instead of introducing STEM fields as related with each other and isolated from other disciplines, we can claim that STEM fields are also effective in different disciplines. This provides students with an awareness of the importance of STEM education. The STEM skill for establishing relevance scheme defined within the scope of STEM skills is given in Figure 2.

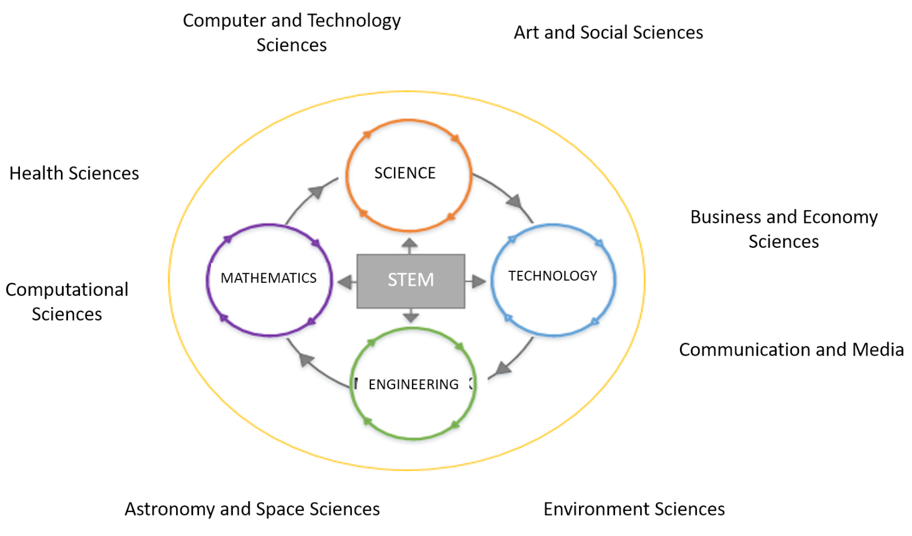

Figure 2. STEM Education Skill for Establishing Relevance

Engineering Based Design Skills

The National Research Council (NRC, 2012) emphasizes, in the development of scientific content knowledge, the importance of integration education that includes engineering design practices. Engineering is defined as "systematic design in producing successful solutions to real life problems" (NRC, 2012). By integrating engineering into education, students have the opportunity to be effective in solving complex problems and decision-making in the future (Mangiante & Moore, 2015). The importance of engineering education arises in having sufficient engineering and scientific knowledge to make solutions to complex social problems such as environment, energy, economy and health, and to participate in discussions and to make decisions in these difficult issues.

It is emphasized by NGSS Lead States (2013) that students should participate in engineering applications according to their interest and experience while developing their engineering skills and equality of opportunity should be provided for them. With

STEM education, it is also stated that the integrated use of scientific knowledge and engineering knowledge in the solution of real life problems is effective in the acquisition of engineering skills of students (Ke, 2014; Thibaut, 2018).

During the STEM education, engineering based design skills are defined by taking into account the skills that students should have in defining the problem, producing solutions for the problem and evaluating the solutions.

Designing: Design becomes salient when students put forward the situation for realistic life problems and develop solution proposals for these problems. Students are expected to design models for the characteristics of the defined problem and to express and reflect these designs in different ways (drawing, modeling, presentation etc.).

Explanation of Design Process: Students are expected to explain the effectiveness of their designs. They need to express themselves what they pay attention to during the design process, whether the design they create is effective in problem solving, and about the developmental stages, and at the same time evaluate whether the design they construct serves to solve the problem.

Selection of Appropriate Materials: Selection of appropriate materials is necessary for putting the designs created by the students for problem solving as products. For this, it is important to test and evaluate different material alternatives. The selection of suitable materials is important for the development of a durable, flexible, and usable product.

Realistic Product Creation: It is important that the designs that are created to solve the problem are realistic and useful. The fact that the products that students bring to the market are not realistic can cause the problem resolution to be limited. It is important to design well and create an effective model in creating realistic products.

Testing Product Quality and Performance: The crated product must be tested in order to check the durability and operation of it.

The usefulness of the product, its functioning and its effectiveness in problem solving should be tested.

Product Evaluation and Improvement: Product effectiveness, its functioning, its fit to desired characteristics, and durability should be evaluated by the student and the product characteristics should be defined. If the product has incomplete or improvable characteristics, they should be detected and revised to be used in the best possible way.

Design and Product Comparison: It is a comparison of the design the student has made for the problem he/she defined with the product characteristics that he/she presents. At this stage, it is expected that students will question the differences and reasons between what is targeted and what is being done. With the "why" and "how" questions, It is aimed to evaluate the stages of creating the product.

Innovation Skills

Today, as innovation and development in the field of economy, technology and industry are rapidly gaining importance, countries need qualified people with appropriate education to increase and support their knowledge base in this race. At all levels of K-12 education, it is necessary to acquire the knowledge and skills necessary for innovation (OECD, 2011).

Innovation skills provide vocational competence and qualification in the direction of objectives. It is seen that there are common skills defined when the literature on innovation skills is examined (Ananiadou & Claro, 2009; Kergroach, 2008; OECD, 2010, OECD, 2001; Stasz, 2001).

Basic Skills and Digital Age Literacy: Basic skills include the skills for reading, writing and arithmetic operations. Digital age literacy, which provides information access and information interpretation of individuals, provides technology flow that enables the use of digital technology, communication tools and networks. With the development of Internet and information and communication technologies (ICT), OECD (2008) stated that digital age literacy has become as important as the basic skills for the future professions.

Academic Skills: These are related to subject areas such as mathematics, science, history and geography. Academic skills are generally acquired through education and transferred to real life and practice.

Technical Skills: These skills are the skills necessary for professional life and include academic knowledge and skills. It is an increasingly important skill for competence in product, service, and development processes in response to complex problems in industrial development and country policies.

General Skills: The skills involved in this category are problem solving, critical and creative thinking, learning, and managing complex situations.

Social Skills: Social skills include motivation, communication, collaboration and responsibility skills that enable individuals to interact within a group or with other groups. The ability to read and manage one's own and others' behavior during social interaction, as well as the development of comprehension, openness and awareness skills for intercultural communication are important. Leadership: This skill includes team building and managing, guidance and coordination skills.

These skills described are confronted as features that individuals who are effective in the innovation process must possess. Green, Jones, and Miles (2007) define innovation processes and effective skills as follows. These are:

1. Choice of ideas and resources: In this first stage, the identification of ideas, the collection of resources, and the selection of appropriate resources are included. Review of sources, interpretation of new information obtained, evaluation of their validity, and discussion of ideas are carried out. Basic, academic, general, and technical skills are important at this stage.
2. Development of innovation ideas: In this stage of development, individuals or different groups come together to share ideas, make decisions and work effectively. Social and leadership skills gain importance at this stage.
3. Testing and commercialization: At this stage, evaluation of trade, benefits and risks takes place. Customer needs and preferences should be determined in the preference of the product. At this stage, engineering and marketing skills are required for product development and commercialization. Risk management, following and identifying innovations are needed.
4. Implementation and expansion: At this stage, project management, technology transfer, and coordination of supply chains are included.

Digital Competence

Digital competence includes the effective utilization and use of information and communication technologies (MoNE, 2018c). Banks and Barlex (2014) state that digital competence should include the following elements:

- Understanding the use of information and communication technologies (books, Internet, television, telephone etc.) and their reflection on society (culture, information access, communication and interaction, meaning making).
- Making use of technological tools to exchange information and create knowledge via technology as well as face-to-face meetings.
- Effectively utilize and critically evaluate communication technologies to acquire information.
- Taking advantage of networks and multimedia to share information accessed with a digitally literate audience.

There is a need for teaching that integrates technology with engineering applications and includes enriched and high quality teaching materials (PCAST, 2010). With STEM education, students are able to use algorithmic thinking, calculation techniques, modeling, and abstraction to solve real life problems by taking advantage of technology (NAE, 2009). Within the scope of STEM education, it is aimed not only to use technology in education environment, but also to develop technology usage skills of students (Sade & Coll, 2003). In STEM education, it is aimed students to benefit from the information and communication technologies in using, accessing and sharing the information with others while making creative designs, through these activities it is aimed students to develop their digital competencies (Thibaut, 2018).

Communication and Collaboration

In STEM education where engineering design-focused work is involved, students interact in a communicative and collaborative way (Crismond & Adams, 2012). Communication and collaboration have emerged as a necessity in K-12 level engineering programs (ABET, 2012). In STEM education, students work together as engineers in a team to present their design projects (Borrego, Karlin, McNair, & Beddoes, 2013).

In STEM education, students use different communication channels such as written, verbal, visual, and technological. Fluent speech, proper reading and writing, and using digital technologies are effective in expressing students' thoughts.

Trilling and Fadel (2009) expressed the importance of effective communication as follows.

Effective communicative individuals;

- Express their thoughts and ideas in verbal, written and different ways of communication in different contexts.
- Are effective listeners in developing meaning towards knowledge, value, and attitude.
- Can communicate with different purposes (informing, motivating, convince etc.).
- Can benefit from information and communication technologies (computers, cameras, printers, smartphones etc.) effectively.

In STEM education, students are provided to work in interaction with different teams and heterogeneous groups. Communication, motivation and entrepreneurship skills are at the forefront in the social interaction of the students. Leadership skills are effective in the formation of teams and coordination within the group when students work in collaboration. The importance of collaboration is described by Trilling and Fadel (2009) as follows:

- Demonstrate the ability to work effectively with respect to different teams.

- Ability to work towards a common goal and to be flexible and adaptable in making joint decisions.
- Contribution of each individual in group work and shared responsibility.

Socially, communication and collaboration in physical or virtual environment with others are provided for the development of communication and collaboration skills of students (Trilling & Fadel, 2009). According to the OECD (2011), social skills in communication and collaboration are important elements in harmonizing and supporting each other in the globalized world. The ability to work in multicultural groups affects the work of the individual in terms of professional and career.

Life and Career Skills

Life and career skills are effective in making individuals fit into work life and real life. In science education program of Turkey in 2017, these skills were described as analytical thinking, decision-making, creative thinking, entrepreneurship, communication, and teamwork (MoNE, 2017).

These skills are also important competencies in STEM education. With STEM education, it is aimed to develop skills for career and business life following the individuals' school life (Hall, 2018). Students need to be knowledgeable about the basic scientific disciplines that will be effective in their future business life. STEM education is effective in providing students with the knowledge and skills necessary for career and personal development (P21, 2015). The Framework for 21st Century Learning (P21, 2011) describes the elements of life and career skills as follows:

Flexibility and Adaptability: The 21st century business environment, working conditions and needs are changing rapidly, so it is necessary to educate individuals who are not only equipped in the sense of knowledge but also adapt to changing conditions, new ideas, and tasks (Kivunja, 2015).

Entrepreneurship and Self-direction Skills: Today, economy and digital technologies are rapidly evolving and changing. This requires employees to be entrepreneurial and self-directed to learn new ideas, concepts, and practices to increase their productivity (Trilling & Fadel, 2009).

Social and Intercultural Skills: In order to be successful in the 21st century business life, the social and intercultural skills of people need to be effective. These skills enable people to work together effectively or to work effectively with the people they communicate with and with different teams (Kivunja, 2015). In the globalizing world, different countries, different societies, and organizations are involved in shared works through collaboration and communication with each other. In this respect, the ability of individuals to work intercultural is important in terms of ensuring communication and collaboration. Productivity and Responsibility: This skill, which is described by Trilling and Fadel (2009) as "producing results", includes the productivity, usefulness and high-quality service elements interacting with each other. Productivity in providing a quality service includes providing economic support by using resources in the best possible way. The utility of the resulting service and product is indicative of productivity in the work.

Leadership: Leadership skills of individuals are effective in coordinating and sharing tasks among individuals in collaborative group and teamwork (OECD, 2010).

Creativity

Creativity is defined as the ability to think differently and produce ideas as a results of different thinking (Guilford, 1959). Amabile (1982) refers to creativity as producing new and appropriate ideas and behaviors. Csikszentmihalyi (1996) defines creativity as new and valuable ideas or behaviors that are revealed as an interaction of the individual in their thought and socio-cultural context.

Sternberg and Kaufman (2010) state that creativity is generally defined as an understanding of authenticity outside of standards, but creativity is a skill far beyond this definition. Some say creativity is very high level and legendary, while others view it as a skill that emerges in everyday life (Craft, 2002). Creativity is associated with artistic activities and practices, as well as scientific understanding and innovations (Runco & Pagnani, 2011). Creativity is generally defined as "the ability to produce a new, qualified and appropriate product (idea, thought, behavior etc.)" (Sternberg, Kaufman, & Pretz, 2002).

A framework of creativity that can be incorporated into the teaching process was created by Rhodes (1961) and a 4-Ps model was defined in this framework (Smith & Smith, 2010). Rhodes (1961) has described four intertwined elements interacting with each other on a basis of creativity; person, process, product, and press. The 4-Ps in this definition are explained below.

Person: This element includes characteristics specific to person such as personality, intelligence, temperament, attitude, and behavior (Zenasni, Besancon, & Lubart, 2008).

Process: This is the most mysterious component of creativity (Guo & Woulfin, 2016). The process includes the creative work in students' practices and activities. In this direction, various theories and models have been presented in evaluating the creativity of the researchers and practitioners. For example, establishing relationships between concepts (Mednick, 1962) or the Gene-Plore model that involves generating ideas for exploring different contexts (Finke, Ward, & Smith, 1992).

Product: The third line of creativity is the product made at the end of the creative process. Not only the constructions, pictures or inventions that are built as products, but also ideas and thoughts that are suitable for embodiment are also included as creative products (Rhodes, 1961). For example, a new building model that the individual has designed may be a product because of its feasibility, even if it has not been built yet.

Press: Press is the last element of creativity. The press is expressed as the environment in which the individual interacts (Amabile et al., 2004). Guo and Woulfin (2016) described elements that include creative environment in schools as teaching style, peer relations, collaboration, competition, and information and communication technologies.

At the STEM activities, it is aimed students to make a product after an engineering based work process. With STEM education, students are offered the opportunity to make products in a creative environment. In this direction, the students have the chance to design, make products, and evaluate these products within the scope of the 4-Ps creativity model.

Conclusion

Despite the fact that the STEM concept is used frequently today, it is seen that the skills to be developed in students with STEM education is not mentioned too much. STEM education is generally seen as a general concept expressing the integration of science, mathematics, technology, and engineering disciplines. It has become important to develop skills that will emerge through the integration of these disciplines with STEM education. In this section, STEM skills by examining the literature is outlined in the form of engineering based problem solving, establishing interdisciplinary relevance, engineering based design skills, scientific process skills, life and career skills, creativity, innovation, and digital competence. In addition to integrating science, technology, engineering, and mathematics subjects in STEM education, the development of STEM skills is also of great importance.

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