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The Metaphorical Perceptions of Science Teachers Regarding STEM Education

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Abstract

The aim of this research is to specify the metaphorical perceptions of science teachers regarding STEM education. The metaphors created by science teachers are interpreted in the World Economic Forum's Future of Jobs Report (2018) according to the skills that should be the most likely in individuals in the future. In this study, phenomenology pattern which is a method of qualitative research has been used. The study group consists of 84 science teachers with STEM education. The participants did not produce any negative metaphors related to the STEM education. 84 valid metaphors are classified using categories such as "Analytical Thinking and Innovation / Creativity, Originality and Sociability", "Active Learning and Learning Strategies", "Technology Design and Programming", "Critical Thinking and Analysis", "Complex Problem Solving/Reasoning, Problem Solving and Understanding", "Leadership and Social Impact" and "Emotional Intelligence". The most metaphors produced categories are "Leadership and Social Impact", "Complex Problem Solving / Reasoning, Problem Solving and Understanding", "Analytical Thinking and Innovation / Creativity, Originality and Sociability", while the least metaphors produced categories are "Emotional Intelligence", "Technology Design and Programming" and "Critical Thinking and Analysis". In this study, it has been concluded that STEM education develops 21st century skills which parallels with World Economic Forum. In this context, STEM education can be more integrated into the teaching programs. Moreover, science teachers who are practitioners of STEM education may be required to have STEM education with in-service training.

Keywords

STEM education
Metaphoric Perception
WEF skills
21st century skills

About the article

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Introduction

The most distinctive feature of developed and developing societies is that they adapt to the economic, scientific and technological changes experienced on a global scale by updating their education systems. As a matter of fact, the production and human resources required in the 21st century have become more important than the land and raw materials taken into account in the 19th and 20th centuries, and changes in the industry have required rapid changes in education systems (Altunel, 2018). In 21st century, since the concepts of 21st century skills, industry 4.0 and PISA (International Student Assessment Program) the integration of disciplines are related to both education and economy, they have been on the agenda of the world countries (Akgündüz, 2018). The changing agendas of countries make it clear that the consideration of current educational approaches and the fields of science, mathematics and technology independently from each other makes it difficult for individuals to acquire high-level skills such as creativity, critical thinking, and problem solving with classical education understanding (Akgündüz, Aydeniz, Çakmakçı, Çavaş, Çorlu, Öner, & Özdemir, 2015). For this reason, countries that give importance to education have moved away from traditional understanding and started to seek new educational approaches. New approach known as STEM education has emerged with the concept of the integration of disciplines, one of the concepts that are in the focus of countries (Akgündüz, 2018).

STEM education has been interpreted in different ways by different people. According to Sanders (2009), the first mention of STEM education was pioneered in the 1990s when the National Science Foundation in America started using 'SMET' for 'Science, Mathematics and Technology'; SMET has transformed into STEM (Erduran & Kaya, 2018). STEM education is an interdisciplinary education movement that aims to integrate the disciplines of science, technology, engineering and mathematics (Daugherty, 2013; Kuenzi, 2008). The general accepted definition of STEM education is as follows: STEM education is an educational understanding that brings different disciplines together by integrating disciplines, enables individuals to absorb 21st century skills, realizes in-depth learning in individuals and provides an opportunity for individuals to use information in daily life (Akyıldız, 2014; Yıldırım & Altun, 2015). In other words, the STEM approach brings individuals against real world problems instead of preparing them for life, and enables people to produce rational solutions to problems.

The purpose of STEM education is to direct individuals to STEM-related fields by integrating the disciplines of science, technology, engineering and mathematics with official or implicit practices from preschool to university (Gonzales & Kuenzi, 2012). Thanks to STEM education, students' interest in science, mathematics and technology increases and students gain a positive attitude towards these areas. According to Thomas (2014) the aims of STEM education;

- Raising individuals who are integrated with STEM literacy and producing the necessary workforce from these people,
- To carry out current work in the STEM field,
- To create new production opportunities that will achieve economic advantage in competition between states,
- In the future, to make individuals qualified for changing professions.

For the stated purposes, it was emphasized that individuals should adapt to changing economic, scientific and technological conditions in the world and individuals should turn to professions that will be in demand in the future.

Giving the necessary importance to STEM education is possible by reflecting it in education policies. Because changes in science and technology have made it necessary for countries to review their education systems. Turkey's adaptation of constructivist educational approach in 2004 proves this. Constructivism is an understanding that the student should be active contrary to the traditional understanding, constructs the individual after absorbing the information instead of taking it as it is, and emphasizes that the individual's prior knowledge, individual difference and learning conditions are important (Özmen, 2004). Constructivism aims to provide individuals with high-level mental skills such as questioning, decision making, and problem solving, taking into account individual differences, perspectives, and life experiences (Çepni & Ormancı, 2018). Along with the individual centred

constructivist approach and educational philosophy, Turkey has stepped into a new era in the field of education, mathematics, engineering and technology began to be given more attention. Constructivism approach that has affected educational studies in 30 years has formed the basis of STEM education (Karataş, 2018). In order to adapt to the new century, Turkey has taken several steps to adapt STEM approach to education policy. In the action plan for STEM education published by the Ministry of Education in 2016, was emphasized that some steps such as establishing STEM education centers, educating teachers in education centers and updating curricula according to the STEM education approach should be considered (MoE, 2016). In 2017, a program for STEM education was drafted and by adding the unit of the 'Science and Engineering Applications' to the curriculum of 4th, 5th, 6th, 8th grades, STEM education has been integrated into the program of science, mathematics and engineering. The draft program prepared by the Ministry of National Education in 2017 "Science, Engineering and Entrepreneurship Applications" was added to the unit instead of Science and Engineering Applications and it was accepted in 2018 (MoE, 2018). In the published program, the most important thing is to teach science, mathematics and entrepreneurship applications, with the aim of helping individuals acquire high-level skills such as creativity, entrepreneurship, communication, teamwork, decision-making, and analytical thinking (Altunel, 2018).

One of the biggest educational movement STEM which is focus of interest in many countries including Turkey, the reason why it is prefered is to establish a relationship between the economy and schools, industry, vocational training, daily life (Yıldırım, 2020). In other words, STEM education supports global entrepreneurship by enabling it to establish connections between school, society and business (Eroğlu & Bektaş, 2016). Therefore, in the economic competition between countries, it is necessary to give importance to STEM education in order to dominate the changing professions and to take part in the global race. Since, it has been stated that professions in STEM field will be the most popular professions that will enable countries to grow as competitive, innovative and raising their living standards in the global economic race (Langdon, McKittrick, Beede, Khan, & Dom, 2011). Therefore, in order to direct individuals to professions related to STEM education, the education process of the individuals should be planned in line with the 21st century skills that individuals should have published by the World Economic Forum. That's why, the skills that the business world wanted individuals to have a century ago quite different from the current expectations (Yıldırım, 2018).

In order for the 21st century individual to be successful in both education and business life, he can think creatively, critically and reflectively, work collaboratively with others, produce solutions to problems, have high communication skills, know how to access the information he needs, have the ability to benefit from technology while reaching information, must be an open, responsible, self-directed individual with advanced social skills (Uluyol & Eryılmaz, 2015). All of these are aimed at adapting the individual to the 21st century and acquiring high-level features such as critical thinking, creative thinking, communication skills and collaboration (Partnership for 21st Century Learning, 2016). Alongside these skills, the World Economic Forum Future of Jobs Report (WEF, 2018), 21st century skills that will be in the top 10 in 2022, which is in line with the 21st century skills, are shown in Table 1.

Table 1. Jobs and skills rising to 2022

PROFESSIONS	SKILLS
• Data Analyst and Scientist	• Analytical Thinking and Innovation
• Active and Machine Learning Specialist	• Active Learning and Learning Strategies
• General and Operations Manager	• Creativity, Originality and Assertiveness
• Software and Application Developer and Analyst	• Technology Design and Programming
• Sales and Marketing Specialist	• Critical Thinking and Analysis
• Big Data Specialist	• Complex Problem Solving
• Digital Transformation Specialist	• Leadership and Social Impact
• New Technology Specialist	• Emotional intelligence
• Corporate Development Specialist	• Reasoning, Problem Solving and Comprehension
• Information Processing Staff	• System Analysis and Evaluation

Source: World Economic Forum, *the Future of Jobs Report 2018*, (World Economic Forum Report, Geneva.

When Table 1 is examined, according to the World Economic Forum Report, analytical thinking and innovation, active learning and learning strategies, creativity, originality and assertiveness come first among the skills that individuals should have in business life. With this report, the skills and characteristics that individuals should have in order to be active and successful in business life were determined. In this context, individuals with STEM education can be prepared for the future by adapting to both the 21st century skills and the future skills determined by the World Economic Forum. Because the world, whose development is increasing day by day, needs individuals who research, question, produce solutions to problems, use information in daily life, know where and how to learn, and at this point STEM education comes to the fore (Altunel, 2018).

When the literature is reviewed, there can be so many studies that were carried out on STEM in Turkey (Erduran & Kaya, 2018; Çepni & Ormancı, 2018; Yıldırım & Altun, 2015; Eroğlu & Bektaş, 2016), however, there are limited studies that focuses on metaphorical perceptions of teachers and candidate teachers on STEM (Aladak, Zorluoglu & Yapucuoglu, 2019; Bozanoğlu, 2017; Ergün & Kıyıcı, 2019; Aksakal & Yılayız, 2019). In the study conducted by Aladak et al., (2019), 53 teachers from different branches who received STEM education were reached, and the metaphors created by the teachers were evaluated on the basis of product and process. At the same time, the metaphorical perceptions created were evaluated by taking 21st century skills into account. As a result, 60.4% of the teachers who participated in the study stated that STEM is process-oriented and 39.6% stated that STEM is product-oriented. And it has been concluded that STEM is both product and process oriented and individuals gain 21st century skills through STEM education. Another study by Bozanoglu (2017) measured the metaphorical perceptions of 30 teachers from different branches towards STEM education. As a result, the majority of the participants in the study stated that STEM applications were 'mind-enhancing, cooperating, motivating, creative and fun' while some of the participants stated 'unnecessary enthusiasm and waste of time, materials are incomplete and inadequate'. In the study, it was emphasized that teachers should be educated and the lack of materials should be eliminated in order to train people suitable for 21st century skills. Another study in which the metaphorical perceptions of science teacher candidates about STEM education were measured Chopper (2019). Teacher candidates participating in the study produced 50 metaphors. As a result of the study, they perceived the STEM education as an approach that aims to raise individuals who provide learning by living and produce solutions to problems. No negative perceptions about STEM education were encountered in the study. Aksakal and Yılayız (2019), in their metaphorical perception study on STEM education, unlike other researchers, a study was conducted by including the field of art (STEM + A or STEAM) to the STEM education. Based on the responses from 47 pre-service science teachers, 20 different concepts were divided into classes such as 'Art, Science, Environment and Life'.

Although there are many studies on STEM education, no study has been conducted on the metaphorical perceptions of science teachers who are implementers of the "Science, Engineering and Entrepreneurship Practices" unit added to the STEM education curriculum of 5th, 6th, 7th and 8th grades. At the same time, evaluating the responses of teachers according to the skills expected from individuals in 2022 by the World Economic Forum, which emphasizes that the skills and professions of the future, makes this study different from other studies. Since, it is highly important to have the skills of the future in individuals and to gain these skills to individuals through education.

The aim of this study is to determine science teachers' perceptions of STEM education and to evaluate metaphors according to the skills individuals should have in 2022. There are some evidences in literature that teachers' opinions about STEM education have a positive effect on teaching while applying STEM education (Thibaut et al., 2018). In this context, the aim of the study is to determine the metaphorical perceptions of science teachers towards STEM education. For this purpose, answers were sought for the sub-problems presented below.

- What are the metaphorical perceptions of science teachers towards STEM education?
- What skills are associated with the metaphors created by science teachers in the World Economic Forum's Future of Jobs Report (WEF, 2018), which will be in the top 10 for individuals in 2022.

Method

Research Model

While evaluating the metaphors created by science teachers for STEM education, the phenomenology design, one of the qualitative research methods, was taken into consideration. Phenomenology investigates the cases that are known about the facts but haven't been had in-depth and detailed information about the subject (Yıldırım & Şimşek, 2006). For this purpose, the perceptions of the individuals in the sample representing the universe about a subject are tried to be determined.

Study group

Purposeful sampling method was used in the study conducted for science teachers, since the participants involved in the study must have experience against the phenomenon (Merriam, 2015). Therefore, a total of 173 science teachers who received STEM education and did not receive STEM education were reached in the first place. In the study, 98 people out of 173 who received STEM training through in-service training were identified.

During the study, 173 science teachers were reached. 56.1% female and 43.9% male teachers participated in the study. 67.1% of the participants are undergraduate, 34.2% postgraduate and 1.7% doctorate. At the same time, 56.6% of the participants stated that they received STEM education and 43.4% stated that they did not receive STEM education. Content analysis technique was used in the analysis of the data, and the questions answered by 98 people who received STEM training and in-service seminars were analyzed to make the study suitable for purposeful sampling. However, when the data were examined, when the missing or incorrect forms were removed, the metaphorical perceptions created by 84 individuals who had STEM education were taken into consideration and evaluated.

Data Collection Tool and Data Collection

In order to measure the metaphorical perceptions of science teachers regarding the concept of STEM education, a semi-structured interview form was prepared by the researchers and the necessary explanations were given to the participants about metaphor in the explanation section. First of all, science teachers participating in the study, were asked to answer the question "What does STEM mean to you?". It was aimed to make sure that the interview form was filled by the participants in a disciplined manner. At the next stage, Participants' STEM education is like ……; because ……" they were asked to complete the sentence. Thus, it was aimed to reveal the metaphorical perceptions of science teachers about STEM education.

Data Analysis

The data in the study was made according to the stepwise data analysis determined by Saban (2009). These stages are respectively coding and separation, identifying sample metaphors, categorizing, validity and reliability, analysis of data. In the coding and sorting phase, the metaphors developed by 98 Science Teachers were examined one by one and 14 forms that gave incomplete or incorrect answers to the questions were selected among the participants. In the stage of determining sample metaphors, the best example of metaphor representing each metaphor was determined, thus it became easier to list the metaphors. In the categorization stage, in order to prove that STEM education prepares individuals for the future, categories were created according to the skills that the World Economic Forum should have in 2022 and parallel to 21st century skills. Since some categories contain close meanings, they have been combined. As a result, evaluation was made under 7 categories. In the reliability and validity phase, the following path was followed: Creating detailed forms and reports in the study, informing the researchers about the study in detail and accurately, and not changing the answers given to the questions on the form increases the validity of the study (Yıldırım & Şimşek, 2006). Therefore, the studies carried out in the process are stated in the study in detail and comprehensively. Expert opinions were consulted to ensure reliability, and the data were evaluated in detail. The reliability of the study was calculated using the reliability formula suggested by Miles and Huberman (1994). Reliability = Consensus / (Consensus + Disagreement) as a result of

the calculation, the reliability of the study was found to be 90%. A reliability higher than 70% indicates that the study is reliable (Miles & Huberman, 1994). The result obtained here is considered reliable for the research. In the data analysis, which is the last step, the frequency and percentile of the data were determined and transformed into quantitative data.

Results

In this part of the study, after the necessary arrangements were made, the metaphors and explanations created by 84 Science Teachers about the concept of 'STEM education' were categorized. The aim is to reveal the perceptions of Science Teachers about STEM education. The educational status of the participants in the study is shown in Table 2.

Table 2. Educational Level of the Participants

Education Level	Frequency	Percentage
License	53	63.09
Master	30	35.71
Ph.D	1	1.19
Total	**84**	**100.00**

In Table 2, 63.09% of 84 science teachers whose metaphorical perceptions were evaluated were found to have a license degree, 35.71% a master's degree, and 1.19% a doctoral degree. Thus, the evaluation was made with 84 people, clearing the answers of those who gave incomplete or incorrect answers. As some of the skills emerging by the World Economic Forum have close meanings, " Analytical Thinking and Innovation ' and 'Creativity, Originality and Assertiveness' skills and " Reasoning, Problem Solving and Comprehension" and " Complex Problem Solving" categories were created by combining their skills. Categories created as "Analytical Thinking and Innovation / Creativity, Originality and Assertiveness", "Active Learning and Learning Strategies", "Technology Design and Programming", "Critical Thinking and Analysis", "Complex Problem Solving / Reasoning, Problem Solving and Comprehension", "Leadership and Social Impact", "Emotional intelligence" in the form. Of the skills listed ,no metaphor has been identified for the category of " System Analysis and Evaluation".

Categories for Metaphors that The Science Teachers Produced for The Concept of " STEM EDUCATION"

Metaphors are properly categorized. These categories are given in Table 3.

Table 3. Categories Created for the Concept of STEM education

Categories	Frequency	Percentage
Analytical Thinking and Innovation/Creativity, Originality and Assertiveness	13	15.47
Active Learning and Learning Strategies	10	11.90
Technology Design and Programming		8.33
Critical Thinking and Analysis	8	9.52
Complex Problem Solving / Reasoning, Problem Solving and Comprehension	14	16.66
Leadership and Social Impact	28	33.33
Emotional Intelligence	4	4.76
Total	**84**	**100.00**

According to Table 3, the metaphors created by science teachers are grouped under seven categories. 15.47% of the metaphors were in the category of "Analytical Thinking and Innovation / Creativity, Originality and Assertiveness", 11.90% "Active Learning and Learning Strategies"; 8.33% "Technology Design and Programming", 9.52% "Critical Thinking and Analysis", 16.66% "Complex Problem Solving / Reasoning, Problem Solving and Comprehension"; 33.33% "Leadership and Social Impact"; 4.76% "Emotional intelligence".

Metaphoric Findings Regarding the Category of "Analytical Thinking and Innovation / Creativity, Originality and Assertiveness" Produced by Science Teachers on the concept of "STEM EDUCATION"

Considering the WEF Skills of the metaphors developed by Science Teachers for STEM education, the metaphors, the frequencies of the metaphors and the explanations of the metaphors are shown in Table 4.

Table 4. Metaphors related to the category of "Analytical Thinking and Innovation / Creativity, Originality and Assertiveness"

Factory (1)	**Key (1)**	**Seed (1)**	**Recycling facility (1)**
With the harmonious work of different disciplines, brand new and original products can be created.	It enables new doors to be opened in education.	We get the reward of our efforts in line with the attention we show. And we create new products.	We get the reward of our efforts in line with the attention we show. And we create new products.
Master (2)	**Investing in the future (1)**	**Novelty (1)**	**Bring back to life (1)**
It enables us to combine existing resources with experiences and produce new solutions.	It is imperative to move forward.	It allows us to keep up with the developing technology and the digitalizing world.	It is an effective process in producing a useful product in the reuse of waste tools and equipment.
Laboratory (1)	**Rainbow (1)**	**Creativity (1)**	**Knit (1)**
New discoveries can be made at any time.	It creates a whole beauty (work, project, lesson) by bringing together different areas.	It arises from needs.	A whole is formed when loop by loop.

When the Table 4 is examined, it can be seen that science teachers produced 12 metaphors as factory (1), key (1), seed (1), recycling facility (1), master (2), investing in the future (1), novelty (1), bring back to life (1), laboratory (1), rainbow (1), creativity (1) and knit (1) related to the category of 'Analytical Thinking and Innovation / Creativity, Originality and Assertiveness'. It can be interpreted that it improves their skills and contributes to the development of this skill. Some of the sentences that represent the category are 'STEM education is like innovation because it allows us to keep up with the developing technology and the digitalizing world' and 'STEM education is like bringing back to life, because it is an effective process of extracting useful products from the reuse of waste tools and equipment'.

Metaphoric Findings Regarding the Category of "Active Learning and Learning Strategies" Produced by Science Teachers on the concept of "STEM EDUCATION"

The metaphors and their explanations produced by science teachers are shown in Table 5 by taking WEF skills into consideration.

Table 5. Metaphors related to the category of "Active Learning and Learning Strategies"

Active learning (1)	**Sunlight (1)**	**Guide of a machine (1)**	**Playing (1)**	**Kibbutz system (1)**
At the end of the process, what and how much we have learned is revealed and gives us the opportunity to control ourselves.	It is necessary to what and how to learn	You know what it is, but you need to learn how to use it.	Provides permanent learning.	It supports and includes a desired behavioral change that enables us to work together with the division of labor, but attain basic scientific satisfaction without any interest.
Rope (1)	**Music notes (1)**	**Space (1)**	**The foundation of the building (1)**	**Requirement (1)**
It easily connects everything and makes learning easier.	The subjects taught with STEM education turn into a pleasant-sounding melody in students.	It contains a lot of information; it is fun and intriguing.	The basis of success will come to us according to our capacity to apply the theoretical knowledge we know.	Generation Z does not want to receive information directly anymore. They want to use the information they get.

According to Table 5, science teachers produced 10 metaphors regarding the category of "Active Learning and Learning Strategies". These metaphors are active learning (1), sunlight (1), guide of a machine (1), playing (1), kibbutz system (1), rope (1), musical notes (1), space (1), the foundation of the building (1) and necessity (1). In the explanation section, it can be interpreted that the participants emphasized concepts such as permanent learning and facilitating learning, and that individuals who received STEM education developed the 'Active Learning and Learning Strategies' skill, which is one of the skills that individuals should have in the future. The most representative sentences of this category are "It is like an exam. It gives us the opportunity to evaluate ourselves" and "It is like a life, teaches what why and how we learn".

Metaphoric Findings Regarding the Category of "Technology Design and Programming" Produced by Science Teachers on the concept of "STEM EDUCATION"

The metaphors and their explanations produced by science teachers regarding the category of "technology design and programming' are shown in Table 6 by taking WEF skills into consideration.

Table 6. Metaphors related to the category of "Technology Design and Programming"

Beehive (1)	**Production (1)**	**Machine (1)**	**Airplane (1)**
You design and build.	It requires design and invention.	The parts become machines by coming together with the integration of technology with education and a useful product emerges.	It will get you to your goal in a very short time. It requires technical knowledge and skills.
The link between technology, design and education (1)	**An upgrade of the technology and design course (1)**	**A newborn baby (1)**	
With this training, more contemporary studies can be done. New inventions can be devised.	The student is active.	It takes time and effort to grow and develop.	

Table 6 shows that science teachers produced 7 different metaphors for the concept of 'technology design and programming'. These metaphors are beehive (1), production (1), machine (1), an upper version of the technology design course (1), airplane (1), the link between technology and design (1), a newborn baby (1). When explanations are reviewed, it can be interpreted that the individuals who have received STEM education have emphasized the concepts such as design and

invention. Thus, it can be said that it develops the skill of "Technology Design and Programming", which is one of the desired skills in the business world. The most representative sentences of this category are "It is like the link between technology, design and education. Because with this training, more contemporary studies can be done. New inventions can be devised."

Metaphoric Findings Regarding the Category of "Critical Thinking and Analysis" Produced by Science Teachers on the concept of "STEM EDUCATION"

The metaphors and their explanations produced by science teachers are shown in Table 7 by taking WEF skills into consideration.

Table 7. Metaphors related to the category of "Critical Thinking and Analysis"

Hard disk (2)	**Multi-dimensional thinking (1)**	**Viewing from different windows of a building (1)**	**Computer (2)**
It deals with all aspects, not just one aspect.	In STEM, there is no single and correct answer, everyone can create different puzzles for the same problem.	Events are viewed from different angles from each window.	It includes the ability to approach problems from all aspects.

Figure 3 shows that science teachers produced 5 different metaphors for the concept of "Critical Thinking and Analysis" such as life (2), hard disk (2), multidimensional thinking (1), viewing from different windows of a building (1), computer (2). Being emphasized the concept of 'multidimensional thinking' by the participants is interpreted as STEM education can develop the desired skills in the future business world. The most representative sentences produced by the participants are "STEM education is like looking from different windows of a building. Because every window looks at events from different angles and gives different ideas."

Metaphoric Findings Regarding the Category of "Complex Problem Solving / Reasoning, Problem Solving and Comprehension" Produced by Science Teachers on the concept of "STEM EDUCATION"

The metaphors and their explanations produced by science teachers regarding this category are shown in Table 8 by taking WEF skills into consideration

Table 8. Metaphors related to the category of "Complex Problem Solving / Reasoning, Problem Solving and Comprehension

Mother (1)	**The drug in the movie 'Limitless' (1)**	**Teacher (1)**	**Pinhole (1)**	**To respond to the need (1)**
Finding solutions to problems.	It allows the brain to become limitless by making new connections.	It produces solutions to problems and solves them.	You can thread by thinking.	With STEM, you can meet your needs.
Technology (1)	**Lighthouse (1)**	**Scientific research process (1)**	**Life (2)**	**Silicone Gun (1)**
It produces the latest solution that makes life easier.	It shows the way.	In STEM education, help is obtained from science about how to solve the problem and scientific process skills are used.	It requires applications in life.	It can be used for problem solving in many disciplines.
Collaboration of different minds (1)	**Puzzle (1)**	**Repairman Apprentice (1)**		
It is the cue of different minds.	It is difficult, but also fun.	It produces a solution to a problem.		

Table 8 shows that science teachers produced 13 different metaphors for the concept of "Complex Problem Solving / Reasoning, Problem Solving and Comprehension" such as "mother (1), the drug in the movie 'Limitless' (1), scientific research process (1), pinhole (1), respond to the need (1), technology (1), lighthouse (1), teacher (1), life (2), silicone gun (1), collaboration of different minds (1), puzzle (1), repairman apprentice". Being underlined the concept of producing solutions to problems by the participants can be interpreted that STEM education provides individuals to gain "Complex Problem Solving / Reasoning, Problem Solving and Comprehension" skill. The most representative sentences regarding this category are "STEM education is like a mother. Because it finds solutions to problems".

Metaphoric Findings Regarding the Category of "Leadership and Social Impact" Produced by Science Teachers on the concept of "STEM EDUCATION"

The metaphors and their explanations produced by science teachers regarding this category are shown in Table 9 by taking WEF skills into consideration.

Table 9. Metaphors related to the category of "Leadership and Social Impact"

Family (1)	**Life itself (1)**	**Combination teaching (1)**	**Solidarity (1)**	**Orchestra (2)**
Good things happen when they are all together.	Life is interdisciplinary.	Science, math, information technology is required.	People from different fields give ideas for the solution of a problem by inspiring by each other.	Each instrument handles the same melody with different timbre and when the integrity is formed, it forms the background music of life.
Society (1)	**Puzzle (3)**	**Chain (1)**	**Our nerve cells (1)**	**Brain (1)**
It can be done alone, can be done in bulk and is suitable for everyone.	In order for the puzzle to function, all parts must be used correctly in exact place.	The parts that make up it are linked like a chain.	The more connections each synapse has with other synapses, the higher the level of knowledge can be. Because as the branches of education support each other, it can develop faster.	Each lobe has a function, but when combined, it becomes more functional.
Galaxies (2)	**Organism (2)**	**Ant nest (1)**	**An analog clock (2)**	**Bridge (1)**
They are arranged in a certain order in the universe.	It is a structure where many systems come together and form.	Ants produce products by working in colonies, not alone.	The gears will not work without coming together.	Each leg has a specific function.
Our Organs (1)	**Collaborative Working (1)**	**Entrepreneurship (1)**	**Car (1)**	
These disciplines are inseparable.	People's investigative spirit works together to achieve better results.	Being assertive and involved is essential for this education. Designing the product for the needs.	In order to reach a goal, all parts must fulfill their duties.	

Figure 6 shows that science teachers produced 18 different metaphors for the concept of "leadership and social impact". These are family (1), life itself (1), combination teaching (1), solidarity (1), orchestra (2), society (1), puzzle (6), our nerve cells (1), brain (1), galaxies (2), organism (2), ant nest (1), an analog clock (2), bridge (1), organs (1), collaborative working (1), entrepreneurship (1)

and car (1). Being emphasized the concepts of collaboration and solidarity by the participants can be interpreted that STEM education gains the skills of "Leadership and Social Impact". The most representative sentences regarding this category are "STEM education is like a society because it can be done both alone and collective forms and it appeals to everyone", "STEM Education is like solidarity. Because people in different fields give each other ideas for the solution of a problem by inspiring by each other".

Metaphoric Findings Regarding the Category of "Emotional intelligence" Produced by Science Teachers on the concept of "STEM EDUCATION"

The metaphors and their explanations produced by science teachers regarding this category are shown in Table 10 by taking WEF skills into consideration.

Table 10. Metaphors related to the category of "Emotional intelligence"

Butterfly cocoon (1)	Inner world (1)	Kindergarden (1)	Exam (1)
It allows the individual to realize their own abilities.	It takes out the knowledge and engineering inside the child, allowing him to discover himself.	You do an activity, but the child studies and learns versatile. For example, motor development in peer relationships affects their development in the cognitive sensory sphere.	It allows us to evaluate ourselves.

Table 10 shows that science teachers produced 4 different metaphors for the concept of "Emotional intelligence". These metaphors are inner world (1), butterfly cocoon (1), exam (1), and kindergarten (1). Being emphasized the concepts of self-regulation and self-awareness by the participants can be interpreted that STEM education improves one of the desired skills in the business world. The most representative sentences regarding the category are "STEM education is the inner world because it extracts the knowledge and engineering within the children and allows them to discover himself".

Conclusion, Discussion and Suggestion

In this study, in which the metaphorical perceptions of science teachers towards STEM education were determined, 70 valid metaphors were produced by science teachers. The metaphors created are categorized according to the skills expected from individuals in the future business world in the World Economic Forum's Future of Professions Report in 2018, which parallels with 21st century skills. These categories are: "Analytical Thinking and Innovation / Creativity, Originality and Assertiveness", "Active Learning and Learning", "Technology Design and Programming Strategies", "Critical Thinking and Analysis", "Complex Problem Solving / Reasoning, Problem Solving and Comprehension", "Leadership and Social Impact" and "Emotional intelligence" in the form. The reason for choosing these categories is to prove whether the skills of creativity, emotional intelligence, active learning, problem solving, and collaboration, which are the skills that the business world expects from individuals in the future, are reflected in the attitudes and thoughts of teachers who have received STEM education. Because the attitudes and beliefs of the teachers, who are the implementers of the curriculum, affect the methods and techniques they use in the classroom, it is necessary to reveal the teachers' thoughts on STEM education and to determine the difficulties they experience (Eroğlu & Bektaş, 2016).

When the findings section is examined, the categories in which science teachers produce the most metaphors are "Leadership and Social Impact", "Complex Problem Solving / Reasoning, Problem Solving and Comprehension", "Analytical Thinking and Innovation / Creativity, Originality and Assertiveness". The categories for which they produce the least metaphor are "Emotional intelligence", Technology Design and Programming" and "Critical Thinking and Analysis". When the metaphors in the categories were examined, it was concluded that science teachers did not produce any negative metaphors for STEM education and they had a positive approach to STEM education.

In present research, it was concluded that science teachers produced metaphors such as 'key,

foundation of building, innovation' for the category of "Analytical Thinking and Innovation / Creativity, Originality and Assertiveness. It can be understood that STEM education as an approach that allows the individual to discover new products, inventions and inventions. There is a similar study was conducted by Ergün & Kıyıcı (2019), named as "Metaphoric Perceptions of Science Teacher Candidates on STEM Education", the participants produced metaphors such as "scientist, an advanced factory, engineer". As a result, it has been concluded that STEM education enables individuals to create new products and find solutions to problems. Likewise, the TUSIAD STEM report published in 2017 supports individuals' perception of 'innovation' in STEM education. In the report of TUSIAD (2017) 'Towards 2023 STEM requirements in Turkey', under the heading of 'the STEM supports innovation' Sweden is given as an example. In this report, drawing attention to Sweden's inventions such as 'seat belt, pacemaker, Skype communication application', it was stated that STEM fields are very important in Sweden and individuals are encouraged to STEM departments by the state. For all these reasons, STEM education is an effective to gain the one of the skills that individuals should have in 2022 by the World Economic Forum, "Analytical Thinking and Innovation / Creativity, Originality and Assertiveness."

For the category 'Active Learning and Learning Strategies', metaphors such as 'butterfly cocoon, active learning, life' were created by the participants, it was stated that the individual evaluates himself with STEM education and included inquiries at the learning stage. As a matter of fact, in active learning, the individual should make decisions on the subjects such as how much he / she should learn and how the learning event should take place, and have responsibility for the subjects to be learned (Açıkgöz, 2003). For this reason, it was clearly seen that the participants in the study had a perception that STEM education improves active learning skills and prepares the individual for future professions.

It was concluded that for the category of "Technology Design and Programming", individuals stated that STEM education is an approach to using technology and creating designs by producing metaphors such as 'beehive, production, the next version of the technology design course, the link between technology and design'. One of the future skills in the business world is 'Technology Design and Programming.' There is a perception that the "skill" will gain individuals with STEM education. For another category, "Critical Thinking and Analysis', metaphors were produced to emphasize "STEM education provides individuals with multi-directional thinking", and it was commented that STEM education is an education that improves critical thinking. Similar to this study, in the study by Aladak et al. (2018) for critical thinking category based on 21st century skills, metaphors such as day and night, Google, living, fluid pressure were created by the participants. And in the study, it was emphasized that there are perceptions of the science teachers that STEM education provides individuals with critical thinking skills and that the participants have a positive attitude and perception on this issue.

In other categories that constitute the most metaphor in the research are "Reasoning, Problem Solving and Comprehension / Complex Problem Solving", individuals used expressions such as 'STEM education finds solutions to problems and makes life easier.' It was stated that STEM education contributes to solving problems of 21st century, moreover, it is highly important for both this century skills and the WEF skills that the future business world expects from individuals. Indeed, problem solving skill was expressed as taking action to resolve when encountering a problem in 2015 in 'STEM education in Turkey Progress Report', it is defined as the first skill to gain in 21st century (Akgündüz et al, 2015).

Another category with the most metaphors in the research is "Leadership and Social Impact". For this category, such metaphors as family, society, our nerve cells, brain" were created, and in the explanation section, it was emphasized that it provides interpersonal cooperation. For both "learning and innovation skills" of the 21st century skills, as well as the division of labor within the scope of WEF skills, it has become extremely important to organize a business together. As a matter of fact, in the study conducted by Çınar, Pırasa, & Sadoğlu (2016), it was stated that STEM education enables cooperative learning and contributes to the socialization of individuals. As a result, when the data and studies were evaluated, it was clearly said that the science teachers participating in the study had the

perception that individuals would gain social life, collaboration and leadership skills through STEM education.

One of the other skills that the business world expects from individuals 'Emotional intelligence'. For this category, such metaphors as inner world, butterfly cocoon, exam, and kindergarten were produced. STEM education was emphasized as realizing one's own talents and discovering their abilities. In the Future Affairs Report of the World Economic Forum that convenes annually in Davos (2018) emotional intelligence was taken as one of the skills of the future, that's why, it is a very important result for STEM education to improve emotional intelligence.

As a result, it will be needed more researchers, problem solvers, environmentally sensitive, who have self-management and self-awareness, who think analytically and critically, who have advanced decision-making skills, and who understand the importance of collaborative work. Therefore, societies need to prepare individuals for the professions that will be in demand in the future and gain the necessary skills to individuals. The skills that the World Economic Forum wants individuals to have in parallel with 21st century skills, so 21st century skills should be well analyzed and included in education systems. Indeed, Turkey is one of the countries that take this issue into consideration, in recent years has taken several steps to prepare individuals for their future profession. In the report of 'Toward 2023 STEM requirements in Turkey' by TUSIAD (2017), the issues are emphasized that 75% of the profession takes place in the STEM areas and also within 5 years the interest of STEM areas will increased. Therefore, it is necessary to include STEM education in the education system and to train individuals in this direction. Furthermore, for the implementation of STEM education that was added to the curriculum in 2018, STEM education should be given not only to volunteers, but also to all science teachers, who are the practitioners of the unit of 'Science, Engineering and Entrepreneurship Practices'. STEM education should be integrated into the curriculum of universities and the development of prospective teachers towards their profession should be supported.

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