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The metaphors of Turkish, Bulgarian and Romanian students on STEM disciplines

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Abstract

This study was conducted with both Bulgarian and Turkish eight-grade students, who studied in two different middle schools. It was aimed to understand Bulgarian, Romanian and Turkish students' metaphors on STEM disciplines. 18 Bulgarian, 23 Romanian and 20 Turkish students voluntarily participated in this study. Within this context, four separate statements were given to the students to be filled with their metaphors. The statement was like "Science looks like ..., because ... ." It is inferred from the results that Bulgarian, Romanian and Turkish students' metaphors are different from each other.

Keywords: Engineering, STEM, science, technology, mathematics, metaphor

1. Introduction

It can be seen that the changes and developments in science, technology and engineering have been increasing in recent years. Those changes and developments can be understood by looking at scientific inventions, technological instruments and machines that are used in engineering fields. They can also effect educational process, methods which are used in school curriculums. Within this context, new approaches, methods can be used with science, technology, mathematics and engineering curriculums. Skills in Science, Technology, Engineering and Mathematics (STEM) are becoming an increasingly important part of fundamental literacy in today's knowledge economy (EUN, 2019). Those 21st century skills are important to prepare students to their future. The Partnership for 21st Century Skills (2011), introduce 21st century's skills "collaborating, communication, critical thinking and creativity. STEM education can be identified as one of new approaches to be used in education. Tsupros, Kohler &

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Hallinen (2009), STEM is an acronym for "Science, Technology, Engineering and Mathematics" that is originally used by the education-related programs of the National Science Foundation (NSF). Toulmin & Meghan (2007), state that STEM literacy is an interdisciplinary area of study that bridges the four areas of science, technology, engineering, and mathematics. It can be claimed that metaphors have a significant role in teaching a scientific concept to students. Niebert, Marsch & Treagust (2012) stated that metaphors help students bridge the gap between their embodied conceptions and the phenomenon to be taught. There are also some indications that they show the educational situations of the countries, such as scientific literacy, technological literacy and mathematical literacy and so on. Bulgarian, Romanian and Turkish students take the international exams such as PISA. Within this context, PISA and TIMSS exams results are significant indications of having information about Bulgarian, Romanian and Turkish students' STEM subjects. We know that the content of questions, which are asked in PISA, focuses on daily real life problems. It is expected that school course programmes should provide students with real life experiences. Thus, students can be backed up with 21st centruy skills such as innovation, creativity, critical thinking skills, team working and etc. To illustrate this statement, some PISA scores can be examined. According to PISA 2012 results, Turkish students ranked at 41st in reading literacy among 65 countries and also they ranked at 43rd in science and 44th in math (OECD, 2012). When focused on PISA 2015 scores it is seen that Turkish students' average score in science is 425; Bulgarian students' is 446 and Romanian students' is 435 (PISA, 2105). Some more PISA results in maths can also be examined within the scope of Turkish, Romanian and Bulgarian students. It has been found that Turkish students' average scores in maths is 420, Romanian students' is 444 and Bulgarian students' is 441 (PISA, 2015). It is known that another important international exam TIMSS focuses on students' literacy in science and maths. In TIMSS, the questions are based on school course programmes. According to TIMSS 2015, Turkish eighth-grade students' average scores in science is 493. As for the average scores in maths; Turkish fourth-grade students' average is 483 and Bulgarian students' average is 524. Both PISA and TIMSS results show that Turkish students have diffculty in learning STEM subjects such as science, math and technology. They can be understood by focusing on some national and international exams such as TIMSS, PISA and PIRLS. This study was conducted with Turkish, Bulgarian and Romanian eighth-grade students. Within this context, some international indicates such as international exams' results, reports and so on should be taken into account to be able to understand both Bulgarian and Turkish students' science, math and reading skills. There can be seen some studies related to STEM Education and metaphors in the literature. However, it has been seen that there are only limited scientific studies conducted with these mentioned fields. Taylor & Dewsbury (2018) stated that the language of science is largely metaphorical and scientists rely on metaphors and analogy to make sense of any scientific phenomena. Pawley and Hoegh

(2011) tried to explore the answers of these two questions: Are there any advantage or disadvantage of pipeline metaphor for researches both in theoretical and methodological way? and What are they? How did pipeline metaphor highlight the real life experiences of women working in engineering for academic contexts?"Aykaç and Çelik (2014), conducted a study related to metaphors and they tried to determine and compare in-service teachers and pre-service teachers' perceptions of the curriculum through metaphors. They found that the metaphors created by the in-service teachers included negative perceptions but the metaphors of the pre-service teachers had more positive perceptions of the education program.

Cannady, Greenwald & Harris (2014) carried out their study based on the following research questions: (1) What proportion of scientists and engineers do not follow the traditional STEM pipeline in their career?, (2) Is it possible call them the ones who keep in step with the pipeline exceptions ora re they just a sizeable subset of the society that metaphor is not able to explain? and (3) Is there any better analytical lens that can be used to examine trajectories toward both STEM degree attainment and career entrance? In her study, Lancor (2015) tried to identify the role of energy in STEM issues focusing on electiricity, earthquakes, big bang theory, radiation and transportation. Most of students created multiple coherent metaphors to explain the role of energy in physics, biology and chemistry courses. Goodnough & Murphy (2017) conducted a study which was a 10-month university-based action research programme carried out by two science teachers. The programme was intended to help improve the teachers' practise of STEM, teaching the students from kindergarten to grade 9. Çalışıcı & Sümen (2018) examined through metaphors the prospective classroom teachers' perception of STEM education approaches. They applied a form on which there was the statement "STEM Education is like....., because....." Finally, they found that prospective teachers got nine different conceptual categories. İdin and Dönmez (2018) investigated seventh and eigth grade students' metaphors within STEM disciplines. Therefore, they found that the students in the study had difficulty in identifying STEM disciplines. Students used metaphors for science and technology instead of each other. According to the literature, this study can be thought as one of the new studies at international level based on STEM Education and metaphors.

1.1. The aim of the study

The aim of this study is to determine what metaphors Bulgarian, Romanian and Turkish eighth-grade students use to identify STEM subjects. Therefore, following subgoals can be given in the scope of the related aim of the study.

- Do the metaphors created by students vary by those countries and what are their possible causes?

- Do the metaphors created by students vary by gender and what are their possible causes?

1.2. Significance of the Study

It is seen that the importance of STEM Appraoch have been increasing in recent years (İdin, 2017). 21st century skills have a significant effect on STEM subjects. If a person faces with any problem in his daily life, he could be able to solve those problems. This could be possible by himself or with a teamwork. It has been found that there have been some studies on metaphors and STEM Education, but they are not enough. This study can be seperated from others, because this is the first study to focus on Bulgarian, Romanian and Turkish students.

2. Method

2.1. Research Method

In this study, qualitative research method was used, and within this context this research was conducted as phenomenography study. STEM subjects were used to determine and understand the meaning of students' metaphors. Phenomenographic qualitative research method was described by Marton (1981). The purpose of Phenomenography is to describe some variations of the conceptions that students have about some specific phenomena. According to Patton (2002), metaphors can help researchers to make some connections between the things that they may know and the things with which they are less familiar.

2.2. Participants of the study

The study was conducted in Bulgaria, Romania and Turkey within three different public middle schools. The study was conducted during the spring term in 2017-2018 education year. It is known that participants of the study have different backgrounds, and to be able to get much more information, a form was developed. 18 Bulgarian, 23 Romanian and 20 Turkish eighth-grade students were included to the study. 8 female students were from Bulgaria, 19 female students from Romania and 12 female students from Turkey; ten male students were from Bulgaria, four male students from Romania and ten female students were from Turkey. In the study, the students were given under codes such as student 1, student 2 and etc.

2.3. Data collection tool

A form was created, which included four fields of science, technology, mathematics and engineering. The data were collected through the participants' completion of the prompt

"Science/Tech/Engineering/Math looks like ..... because..... ." 61 eighth grade students were asked to write their metaphors on STEM subjects.

2.4. Data Analysis

The data were sent to two assessment and evaluation specialists to provide validity and reliability. Specialists took all metaphors and then they determined and classified metaphors under STEM subjects. The data were analyzed by using document analyze technique. Specialists did their analyses independently, and Miles and Huberman (1994) compatibility percentage formula was used to determine reliability of the data. It was found to be 94.36. It can be said that if a compatibility percentage is at 70 and above 70, it might be used (Yıldırım ve Şimşek, 2011), and that value should be above at least 80 % (Miles and Huberman, 1994; Patton 2002). It is seen that 94.36 is higher than 80, so it can be said that this value is enough for the reliability of the data.

2.5. Ethics

After necessary permission was taken from the schools' administrations, school students were informed about the study, its content, reason, period and which applications would be used during the study. Students were also asked to participate in the study voluntarily. Within this context, they were given "Volunteer Participation Form".

2.6. Data collection process

Students were asked to fill in the blanks with their metaphors. There are four different statements related to aim of the study. These statements are given below.

Science looks like …… because ……..

Technology looks like …… because ……..

Engineering looks like …… because ……..

Mathematics looks like …… because ……..

It is actually seen that the statements consist of two parts. In the first part it is as "Science looks like ……" and the second part is as "because ……..". So in the first part, students wrote their own metaphors related to STEM Subject and in the second part they had to reveal their reason why they had written those metaphors.

3. Results

In the table 1, all metaphors that are created by students on science are given.

Table 1. Metaphors of Science

TURKEY				BULGARIA				ROMANIA			
Metaphor	f		%	Metaphor	f		%	Metaphor	f		%
	Girl	Boy			Girl	Boy			Girl	Boy	
Life	2	1	16,66	reaction	1	1	13,33	Ball	3	1	18,18
light	1	2	16,66	chemistry	1	1	13,33	Mobile phone	2	-	9,09
sun	1	1	11,11	infinity	1	-	6,66	Puzzle	2	-	9,09
experiment	1	1	11,11	Complex study	-	1	6,66	history	-	2	9,09
Discovering sometihing	1	-	11,11	Basic study	1	-	6,66	Orange	2	-	9,09
intelligence	1	-	11,11	Something you need to do understand	-	1	6,66	magic	1	-	4,54
formula	-	1	11,11	Magic	-	1	6,66	brain	1	-	4,54
Electric	-	1	11,11	Hard work	-	1	6,66	Cube rubic	1	-	4,54
key	1	-	11,11	A universe	1	-	6,66	Large	1	-	4,54
A candle which is burns in a dark-room	-	1	11,11	Discovering	-	1	6,66	Right	1	-	4,54
duty	1	-	11,11	nature	1	-	6,66	Book	1	-	4,54
math	1	-	11,11	experiment	-	1	6,66	Fire Works	1	-	4,54
				gravity	1	-	6,66	Mansion	-	1	4,54
								Tree	1	-	4,54
								Story	1	-	4,54

While 18 Turkish students wrote their metaphors on science, two of them did not write any metaphor related to science concept. While 15 Bulgarian students wrote their metaphors on science, three of them did not write any metaphor related to science concept. While 22 Romanian students wrote their metaphors on science, one student did not wrote any metaphor. It has been found that Turkish students mostly used life and light (f=2) when they first identified science via a metaphor. Meanwhile, Bulgarian students mostly created reaction and chemistry (f=2). Romanian students mostly used

ball (f=2) when they identified science via their metaphor. It has been seen that Bulgarian and Turkish students have common metaphors on science subject such as discovering and experiment. Romanian students created some different metaphors to identify science such as history, orange and ball etc. There are some statements given by Turkish, Bulgarian and Romanian students on science such as "A candle which burns in a dark room and something you need to do to understand". It is thought that to focus on the reason of their statements can give deeper information. A Turkish student as coded S2 wrote "Science looks like a candle which burns in a dark-room. Because it is a thing which enlightens the darkness." A Bulgarian student as coded S5 wrote "Science looks like something you need to understand. Because it is essential." A Romanian student as coded S8 wrote "Science looks like a ball because it is in the shuflle." There were some other metaphors by both Bulgarian, Romania, and Turkish students, which were not directly related to science metaphors such as duty and key (Turkish students, S7 and S12), hard work and basic study (Bulgarian students, S4 and S12) and ball (S1, S3, S12 and S17), mansion (S19), story (S21) orange (S6 and S13). Science metaphors also give us some data of the metaphors that were used by Bulgarian, Romanian and Turkish students. These metaphors such as "experiment and discovering something" were given by Turkish students and "reaction, chemistry, experiment, gravity and discovering" were given by Bulgarian students and the metaphor "magic" was given by a Romanian student within science. Here, it can be seen that Bulgarian students used more metaphors related to science than Turkish and Romanian students. Although Romanian students could not create metaphors which are directly related to science, it can be seen that they have created metaphors in their sentences which are directly related to science. For instance, earth, universe, chemistry, curiosity, physics, biology, motion, inquiry, experiment, environment, anatomy and etc. The reason of this situation was asked to their teachers. They stated that their students could not firstly think of direct metaphors which identify science. This means their readiness is not enough to create metaphors related to science. When we focus on the metaphors on science created by both girls and boys, girls are more successful than boys in three countries. This means girls created more metaphors than boys, which are also more related to science.

In the table 2, all metaphors that are created by students on technology are given.

Table 2. Metaphors of Technology

TURKEY				BULGARIA				ROMANIA			
Metaphor	f		%	Metaphor	f		%	Metaphor	f		%
	Girl	Boy			Girl	Boy			Girl	Boy	31,81
discovering	1	2	15	machine	1	2	17,64	Arrow	4	3	9,09
invention	1	1	10	interesting	1	1	11,76	Plane	2	-	9,09
innovation	1	1	10	computer	1	1	11,76	car	1	1	9,09
design	2	-	10	smartphones	1	1	11,76	Brain	2	-	9,09
life	1	1	10	dreaming	2	-	11,76	Viruse	1	-	4,54
computer	1	1	10	innovations	-	1	5,88	rainbow	1		4,54
phone	1	1	10	Modern study	1	-	5,88	puzzle	1	-	4,54
light	1	-	5	code	-	1	5,88	light	1	-	4,54
sun	-	1	5	Something that is difficult to understand	-	1	5,88	Cube rubic	1	-	4,54
science	1	-	5	An endless World	1	-	5,88	Curcubeu	1	-	4,54
math	-	1	5	A robot	-	1	5,88	ball	1	-	4,54
eraser	-	1	5					plan	1	-	4,54
								important	1	-	4,54

All Turkish students wrote their metaphors on technology. While 17 Bulgarian students wrote their metaphors on science, one of them did not write any metaphor related to technology concept. While 22 Romanian students wrote their metaphors on science, one of them did not write any metaphor related to technology concept. It has been found that Turkish students mostly used discovering (f=3) when they first identified technology via that metaphor. Meanwhile, Bulgarian students mostly created machine (f=3). Romanian students mostly used arrow (f=7) when they first identified technology via that metaphor. It is seen that Bulgarian and Turkish students have a common metaphor on technology, which is "innovation". And also Romanian and Turkish created a common metaphor, "which is light". There is no common metaphor between Romanian and Bulgarian students related to technology. It is also seen that a Turkish student coded S11 used science metaphor to identify technology. This means that the student coded S11 do not know the exact meaning of technology. The reason of our claim becomes clear when we look at her statement that Technology looks like science, which means she thinks that science has the same duty with technology. There were some other metaphors by Bulgarian, Romanian and Turkish students, which were not directly related to technology such as life, light and sun (Turkish students, S9, S15 and S17), dreaming, modern study and an endless world (Bulgarian students, S1 and S8), and ball, plan and important (S9, S17 and S22). Technology metaphors also give us some data of the

metaphors that were obtained from Bulgarian and Turkish students. The metaphors such as "invention and innovation" were written by Turkish students and the metaphors "innovation and machine" were provided for science. Although Romanian students could not create metaphors directly related to technology, it can be seen that they used metaphors directly related to technology in their sentences like computer, tablet, keyboard, innovation, phone, file, creativity, IT, printer, internet, laptop, microchip, projector, and etc. Romanian students mostly used the tools related to computer in order to identify technology. The reason of why of it was asked to their teachers. They stated that their students could not firstly think of direct metaphors which could identify technology and thus they used scientific concepts to identify technology. When we focus on the metaphors created by both girls and boys for science, girls are more successful than boys in Turkey and Romania. Boys in Bulgaria created more metaphors related to technology than girls.

Table 3. Metaphors of Engineering

TURKEY				BULGARIA				ROMANIA			
Metaphor	f		%	Metaphor	f		%	Metaphor	f		%
	Girl	Boy			Girl	Boy			Girl	Boy	
creavity	2	1	15	machine	1	2	20	cube	2	1	17,64
math	2	1	15	mechanic	1	1	13,33	house	2	1	17,64
imagine	1	1	10	İnvent	-	1	6,66	block	1	1	11,76
talent	1	1	10	robotics	-	1	6,66	Maghıfyıng glass	1	-	5,88
art	2	-	10	technology	-	1	6,66	Light	1	-	5,88
drawing	1	-	5	Logical study	1	-	6,66	Puzzle	1	-	5,88
science	-	1	5	Hard job	-	1	6,66	route	1	-	5,88
making	-	1	5	creator	1	-	6,66	arrow	1	-	5,88
design	1	-	5	Unprofitable job	-	1	6,66	Build	1	-	5,88
glass	-	1	5	dreaming	1	-	6,66	Creativity	1	-	5,88
occupation	-	1	5	A game	-	1	6,66	Boulder	1	-	5,88
wisdom	-	1	5	improve	1	-	6,66	Roultte	-	1	5,88
invent	-	1	5								

As it can be seen from table 3 that all Turkish students created their own metaphors on engineering concepts. While 15 Bulgarian students wrote their metaphors on engineering, two of them did not write any metaphor related to engineering concept. While 17 Romanian students wrote their own metaphors on engineering, six of them did not write any metaphor related to engineering concept. It has been found that Turkish students mostly used creativity, math (f=3), imagine (f=2), talent (f=2) and art (f=2) when they first identified engineering via a metaphor. Meanwhile, Bulgarian students mostly

used the metaphors machine (f=3) and mechanic (f=2). Romanian students mostly created the metaphors cube (f=3) and house (f=3). It is seen that Bulgarian and Turkish students have a common metaphor on engineering subject, which is "invent". While Turkish and Romanian students created a common metaphor "creativity", Bulgarian and Romanian students have no common metaphor for engineering. It has been found out that there appeared some interesting metaphors and it is necessary to focus on the statements to be able to understand the reason why those metaphors were used. To illustrate this, both Turkish and Bulgarian students' statements were examined. A Turkish student coded S10 wrote "Engineering looks like art. Because somethings are done by hand." A Bulgarian student coded S3 wrote "Engineering looks like a game, because you can choose the rules." A Romanian student coded S6 wrote "Engineering looks like house, because it is built." There were some metaphors by Bulgarian, Romanian and Turkish students, which were not directly related to engineering, such as wisdom (Turkish student S11) a game, unprofitable job and hard job (Bulgarian students, S9, S13 and S18) and boulder, roulette and block. Engineering metaphors also provide us some data of the metaphors that were created by Bulgarian and Turkish students. The metaphors for engineering such as "drawing, science, creativity, design and invent" were given by Turkish students, and the metaphors "machine, mechanic, technology, robotics" were given by Bulgarian students. Although Romanian students could not create metaphors directly related to engineering, it can be seen that they created metaphors in their sentences directly related to engineering like mechanic, energy, construction, material, calculation, building, motor, technical works and etc. The reason of it was asked to their teachers. They stated that their students could not firstly think of direct metaphors which identify engineering and thus they used scientific concepts to identify engineering. Although Turkish male and female students created an equal number of metaphors related to engineering, it is found that Turkish male students' metaphors are more related to engineering than those of Turkish girls. Bulgarian male students' metaphors are more related to engineering than those of Bulgarian girls. Romanian female students' metaphors are more related to engineering than those of boys.

In the table 4, all metaphors that are created by students on math are given.

Table 4. Metaphors of Math

TURKEY				BULGARIA				ROMANIA			
Metaphor	f		%	Metaphor	f		%	Metaphor	f		%
	Girl	Boy			Girl	Boy			Girl	Boy	
number	2	1	15,78	number	2	2	28,57	Rubic cube	1	1	11,11
labyrinth	-	2	10,52	A puzzle	1	1	14,28	Sphere	2	-	11,11
life	1	1	10,52	A very difficult study	-	1	7,14	language	1	1	11,11
human	1	1	10,52	stressful	-	1	7,14	Straight	2	--	11,11
balance	1	1	10,52	A logical study	1	-	7,14	needle in the haystack	2	-	11,11
Four operations	2	-	10,52	An interesting thing	1	-	7,14	İnfinite	2	-	11,11
x, y	-	1	5,26	logic	-	1	7,14	Horizon	1	-	5,55
complexity	-	1	5,26	trigonometry	1	-	7,14	Foreign language	1	-	5,55
intelligence	1	-	5,26	A chain	-	1	7,14	Tangle	1	-	5,55
occupation	1	-	5,26	calculation	1	-	7,14	Ball	1	-	5,55
brain	-	1	5,26					Shell	1	-	5,55
engineering	-	1	5,26					map	1	-	5,55

While 19 Turkish students wrote their metaphors on maths, one of them did not write any metophors related to maths concept. While 14 Bulgarian students wrote their metaphors on maths, four of them did not write any metaphors related to maths concept. While 18 Romanian students wrote their metaphors on maths, five of them did not write any metaphor related to maths concept. It has been found that Turkish students mostly used the metaphors "number (f=3), labyrinth (f=2), life (f=2), human (f=2) and balance (f=2)" when they first identified maths via a metaphor. Bulgarian students mostly created the metaphors "number (f=4) and a puzzle (f=2)". Meanwhile, Romanian students mostly created the metaphors " rubic cube, language, straight, infinite and needle in the haystack (f=2)". It is understood that Bulgarian, Romanian and Turkish students have no common metaphors on maths subject.

There were some metaphors by Bulgarian, Romanian and Turkish students, which were not directly related to maths metaphors, such as intelligence, occupation, brain and engineering (S1, S9, S12 and S19), ball (S15), map (S4), needle in the haystack (S20), Shell (S12) and an interesting thing, stressful, a very difficult study and a chain (Bulgarian students, S2, S6, S15 and S18). To be able to learn much more information of the metaphors, some statements given directly by Turkish, Bulgarian and Romanian students could be examined. For example, a Turkish student coded S14 stated that "Maths looks like an occupation, because most of them are maths." It can be claimed from this statement that this student actually tries to say that maths is everywhere of our life.

Her metaphor could be accepted when it is considered from this point of view. When we focus on Bulgarian students' metaphors, we could see a similar situation. The statement "Engineering looks like a chain because if you miss something, the chain will be broken", which was made by S3, makes it clear to see this similarity. From his metaphor "a chain" , it can not be directly understood why he wrote that metaphor to identify it. It is clearly seen that he actually tries to say that mathematics, some operations and rules support each other. If you miss something in the process, you will not be able to complete the operation. However, in a metaphor given by a Bulgarian student coded S9, it writes "Mathematics looks like an interesting thing, because if you understand it, you will love it". A Romanian student coded S21 stated that "Maths looks like a rubik's cube, because it's complicated to understand the solution." It can be inferred from this statement that this student actually tries to say that maths is actually difficult to learn. Her metaphor can be accepted if considered from this point of view. Maths metaphors also provide us with some data of the metaphors by Bulgarian, Turkish and Romanian students. The metaphors such as "Four operations, x, y, number" were given by Turkish students and "number, a puzzle, logic, trigonometry, calculation" were given by Bulgarian students, and "infinite, tangle, foreign language and straight" were given by Romanian students for maths subject. Here, it can be seen that Bulgarian students used more metaphors related to math than Turkish and Romanian students. Turkish male students created more metaphors than girls, but it is seen that girls' metaphors are more related to maths. Bulgarian female and male students created an equal number of metaphors, but girls' metaphors are more related to maths. While the number of Romanian female students are much more than that of male students, they created more metaphors than boys.

Table 1. Table title (this is an example of a table)

Variables	Two-way MANOVA											
	Main Effect						Interaction Effect					
	Λ	df	F	Sig.	ŋ²	power	Λ	df	F	Sig.	ŋ²	Power
Gender	.956	3;191	2.898	.036*	.044	685	-	-	-	-	-	
Grade	.977	3;191	1.471	.224	.023	385	-	-	-	-	-	
GPA	.978	3;191	1.459	.227	.022	383						
Grade*Gender	-	-	-	-	-	-	.971	3;191	1.920	.128	.029	.491
Gender*GPA	-	-	-	-	-		.958	3;191	2.825	.040*	.042	.672
Grade *GPA							.961	3;191	2.606	.053	.039	.633

4. Discussion, Conclusions and Recommedations

The metaphors, which were created based on STEM subjects, were analysed in the study. It was seen that Bulgarian, Romanian and Turkish students had some difficulty in creating metaphors related to STEM subjects. Hansen, Richland, Baumer, & Tomlinson (2012) stated that engaging students in critical thinking about metaphors can be a way of enhancing their creativity and conceptual understanding of science content. It was also found out that some students have some difficulty in differentiating science and technology. They confused those subjects, and it was directly understood from their metaphors. At this point, it can be said that those students had some misconceptions on science and technology because they did not know what science and technology means. We can also understand that they could not create any metaphors directly related to science and/or technology. The reason of it was found by consulting their STEM field teachers. For Turkish students, teachers stated that science and technology concepts in Turkish are especially taught together, as it was seen in the examples. Another reason can be that teachers use wrong examples when they are conducting any science and/or IT course. This reason can also be valid for Bulgarian and Romanian STEM field teachers. This result shows us that Turkish, Romanian and Bulgarian teachers are necessary to review their students' knowledge on science and technology. European Comission (2018), Although the proportion of graduates in STEM for Romania is above the EU-average the number of STEM graduates is low due to low participation in higher education. The proposition of graduates in STEM for Bulgaria is under EU-average.

There are some studies related to this result in the literature. There should be a focus on students' metaphors for STEM subjects, who could not create any right metaphors, because some of their sentences were not enough to explain both the meaning and the reason of metaphors. From this point view of, it can be said that these students neither can create any metaphor nor write any meaningful reason of their metaphors. It can be inferred from the data obtained that these students can not get their knowledge in touch with the STEM subjects when they are asked to create some new things such as new concepts and so on. Parents' educational status play an important role for students to have quality STEM Education. Hall, C., Dickerson, J., Batts, D., Kauffmann, P. & Bosse, M. (2011), indicated in their study that parents and teachers influence on their students' career choice. They also stated, while parents and teachers represented strong influences on consideration of potential careers, their knowledge of STEM occupations was found to be limited. The parents of Turkish, Bulgarian and Romanian students have different educational status. While Bulgarian students' parents have higher educational status, Turkish students' parents do not have higher educational status. UNESCO (2017), states education systems and schools have a central role in determining girls' interest in STEM disciplines and in providing equal opportunities to access and benefit from quality STEM education. It is also emphasised in the report that girls appear to lose interest in STEM subjects with age, and lower levels of participation are already seen in advanced studies at secondary level. The results of this study is also in the same direction. It may be

bringed forward that girls should be supported with STEM disciplines. The European Institute for Gender Equality (EIGE) (2019), revealed that getting more women into STEM education will have a positive impact on economic growth in the European Union. It has been found that the girls' metaphors for these three countries are more related to science than those of boys. Bulgarian male students' metaphors in technology are more related to technology than those of girls. Both Turkish and Romanian male students created more metaphors related to technology. Both Turkish and Bulgarian male students created more metaphors which were more related to engineering. Romanian female students' metaphors in engineering are more related to engineering than those of girls. Haynes (2019), found in his study that advanta-based metaphors are used to support a positive description of women in engineering. Besides, metaphorical analysis is an appropriate method for conducting research. In these three countries, girls' metaphors are more related to maths than those of boys.

Students can be taught the meanings of science and technology by some applications and activities such as scientific experiments, software applications, coding, mobile learning applications and so on.

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