



Research Article

## The investigation of middle school students' entrepreneurial skills in terms of Entrepreneurship-Based STEM Education: A mixed method study

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### Abstract –

This study was carried out to investigate middle school students' entrepreneurial skills in terms of E-STEM education. The universe of the study comprised of middle school students in a rural area. The sample of the study, in which single group pre-and post-test design was used, consisted of 20 eighth-grade students. The mixed method was preferred. The entrepreneurship scale was used to obtain quantitative data. Semi-structured interview form was used to obtain qualitative data. E-STEM education was given to the students for 8 weeks. Pre-and post-test means of quantitative data were compared by paired-sample t test and content analysis method was used to analyze qualitative data. As a result, the scores of students' entrepreneurial skills and sub-dimensions of entrepreneurship increased in favor of the post-test, although the overall increase was not significant. In addition, according to qualitative data, it was observed that E-STEM activities had a positive effect on the sub-dimensions.

*Key words:* entrepreneurship, middle school students, STEM activities

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## **Introduction**

Education has gained a new definition in terms of its purpose and function in 21st-century society. The reason for this change stems from the fact that the developments in today's society and economy require people who are equipped and qualified with certain skills (Ananiadou & Claro, 2009). Skills that individuals require in our age are included in "21st-century skills" (Johnson, 2009). "Entrepreneurship" is one of these 21st-century skills included in the category of "career and life skills" (Trilling & Fadel, 2009). Hindle and Rushworth (2000) have asserted that entrepreneurship is an activity that is a fundamental factor in the creation and management of a new organization designed in order to create a unique and innovative opportunity. It has been mentioned that statements defining entrepreneurship focus on using the skills that characterize entrepreneurial individuals and the processes that play a part in entrepreneurship (Nafukho et al., 2010). Rocha and Birkinshaw (2007) have drawn attention to the discourse that an entrepreneur is defined as the owner of a small or medium-sized company or a new businesses. Some studies concerning entrepreneurship have indicated that entrepreneurship has been regarded as a key element of rising living standards (Azoulay et al., 2018). However, it has been argued that successful entrepreneurship is rare among societies and the vast majority of entrepreneurs fail to deliver major or creative innovations (Azoulay et al., 2018). Therefore, more emphasis should be placed on the development of entrepreneurial characteristics of individuals in order to prevent this failure and to create an innovative society.

In studies conducted on this subject, students were given entrepreneurship training for the purpose of promoting entrepreneurial skills and increasing the number of entrepreneurial individuals and it has been observed that these trainings have contributed to the entrepreneurial skills of the students. Lepuschitz et al. (2018) conducted a pilot study in two schools in Vienna, Austria for the purpose of the development of entrepreneurial skills in middle schools. Some activities including robotics, marketing, business management, problem solving, teamwork were carried out by the students within the scope of this entrepreneurship education. It has been speculated that these practices could improve the entrepreneurial skills of middle school students. Another research conducted by Sanchez (2013) has focused on the effect of entrepreneurship education on students' desire to start a new job. This entrepreneurship program consists of four basic components:(1) basic teachings of management and marketing adapted to the age of the students; (2) practices in skills such as self-efficacy and risk taking; (3) business plan and (4) interaction with practice and,

consequently, a significant increase has been observed in favor of the experimental group and revealed that entrepreneurship education positively affected students' desire to start a new job. Moreover, in another study conducted by Uygun and Güner (2016), university students were informed about the characteristics of entrepreneurial individuals, entrepreneurship culture, innovation and creativity, as well as details of business establishment and financial planning during the 14-week training period. The results of this study have indicated that entrepreneurship education contributes to the formation of positive results in terms of entrepreneurial knowledge and skills. In addition, Avcı (2018) has examined the effect of differentiated teaching practices, which include skills such as risk taking, teamwork, creativity, critical thinking, and problem solving, on students' entrepreneurial skills and a significant increase in entrepreneurial skills of the experimental group has been found. In addition, the acquisition of entrepreneurial skills at early ages is considered to be a serious issue besides many other skills (Tarhan & Kılıç, 2017). Therefore, it was considered that the idea of integrating the education given to primary school students with entrepreneurial skills would be appropriate. STEM education which aims to develop 21st-century skills and entrepreneurial competencies was preferred for the implementation of the research in accordance with the purpose. The term "STEM education" refers to the teaching and learning process in the fields of Science, Technology, Engineering and Mathematics (Gonzalez & Kuenzi, 2012). STEM education also has common goals with the 21st century society in terms of being an instructional model that enables individuals to develop entrepreneurial and collaborative work as well as high-level skills (Walan, 2019). In addition, Deveci (2018) stated that STEM education and the concept of entrepreneurship which is one of the 21st century skills have been emphasized recently. Furthermore, the inclusion of the concept of entrepreneurship under the name of "life skills" in the new middle school science curriculum has indicated that the goals of the new curriculum have a common ground with the STEM approach (Deveci, 2016). STEM education has a sub-field called E-STEM (Entrepreneurship, Science, Technology, Engineering, Maths) (Caldwell et al., 2018). It is aimed to acquire entrepreneurial skills as well as other acquisitions via this field which is composed of the integration of entrepreneurship and STEM education (Ezeudu et al., 2013). In addition to the main goals of STEM education, orienting individuals to professions that include entrepreneurship has been one of the goals of this sub-field (Langdon et al., 2011). One of the main reasons for this situation has been the increase in the rate of occupations involving STEM fields in recent years (Caldwell et al., 2018). According to Farwati et al. (2021), teachers implement STEM education to develop students' entrepreneurial skills and various

21<sup>st</sup> century skills. Ahmad and Siew (2021) emphasized the importance of integrating entrepreneurial thinking into STEM education. Shahin et al.(2020) investigated the effects of STEM-based entrepreneurship program on entrepreneurial intention of female students. The findings of the study indicated that the entrepreneurship program developed female students' entrepreneurial attitudes, skills such as problem solving, creativity, leadership, and risk taking. Thus, it is essential for individuals who will choose E-STEM-related professions in the future to gain knowledge and experience in E-STEM fields so that individuals could have the opportunity to get a job and start a business. In this context, it is possible for students to develop both their entrepreneurial characteristics and engineering skills via E-STEM education (Deveci et al., 2015).

The research is significant in terms of focusing on STEM education and entrepreneurial skills which have been the issues coming to the fore in recent years. Moreover, despite the fact that there are many STEM related studies focusing on problem solving, critical and creative thinking skills (Çakır, 2018; Öztürk, 2018; Topsakal, 2018; Aydın, 2019; Özkızılcık & Cebesoy, 2020), the number of studies examining the effect of STEM education on entrepreneurial skills is relatively limited (Konus, 2019; Deveci, 2018). In addition, the acquisition of entrepreneurial skills is highly vital as in today's society due to the fact that individuals are expected to establish their own businesses, produce creative solutions to problems, act with confidence and be aware of themselves. Therefore, individuals need to be taught and trained in this field in order to acquire entrepreneurial skills. Because of the fact that these features and the possibility of emergence of these features are closely related to entrepreneurial skills of individuals. In addition, Nicolaidis (2011) drew attention to the fact that entrepreneurship is an important factor especially for the developing societies. Stevenson (2000) stated that enterprises play a key role in establishing a business and the importance of this skill has increased in the rapidly developing technology age. Aytaç (2006) suggested that entrepreneurial skills are an advantageous feature for children in terms of self-sufficiency and self-confidence. Besides, Abbasi et al. (2011) argued that entrepreneurial skills play a key role in individuals in terms of affecting leadership and communication skills as well. In this context, it can be inferred from these statements that entrepreneurial skills are also necessary for the socialization of students. Development of entrepreneurial skills enable students to create a certain profile in their future lives. Daniel et al. (2017) drew attention to the impact of entrepreneurship on economic independence and claimed that this impact may be able to help individuals establish their own businesses or find a good job in the future, provided that the

education on entrepreneurial skills can be effective. Based on these assertions, it is suggested that more attention must be paid to the studies on entrepreneurial skills and the factors affecting students' entrepreneurship. Thus, this study aimed to examine the entrepreneurial skills of middle school students in terms of entrepreneurship-based STEM education carried out with simple materials. In addition, determining the entrepreneurial perceptions of students before and after the implementation is one of the aims of the research. Besides, it is also aimed to provide middle school students with a basic perspective on STEM education with cost-effective and easily available materials. Thus, answers to the following questions were sought in the study.

1. Does entrepreneurship-based STEM education have an impact on middle school students' entrepreneurial skills?
2. What are the middle school students' entrepreneurial perceptions before and after the implementation?

## **Method**

### *Study Sample*

The universe of the study comprised of middle school students being educated in a rural area and the study sample consisted of 20 eighth-grade rural students ranged in age from 13 to 14 years. The research was conducted in the fall and spring semesters of the 2019-2020 academic year. Purposive sampling method was used in sample selection. The purposive sampling method is the determination of the study sample based on specific objectives or qualities (SA et al., 2021). The qualities considered in this research are "homogeneity" and "convenience". Purposive sampling method enables the sample selections including groups that are easily accessible (Nartgün & Kaya, 2016) and homogenous in terms of age, culture and socio-economic status (Etikan, 2016).

### *Research Design*

"Mixed method" in which qualitative and quantitative methods are both used was preferred in the study. It is seen that the mixed method is interpreted differently by many researchers. While Venkatesh (2013) and Leech et al. (2010) simply define the mixed method as a method created by the combination of qualitative and quantitative designs, for some researchers, the mixed method is more than a simple combination of two approaches due to its integrative role in study results (Morse & Cheek, 2015). Caruth (2013) suggested that mixed method can offer broader insights and generate more knowledge. These features are mainly related to the pragmatic nature of the mixed method (Hall, 2013). Therefore, the mixed

method was chosen in this study in order to better explain the quantitative data and to enhance the perspective and understanding of the study results. The mixed method basically includes three different designs that are named as; convergent design, sequential-exploratory design and sequential-explanatory design (Creswell, 2013). Explanatory design was used in this research, since quantitative methods were applied first, and then qualitative methods were used to confirm the quantitative data and to explain them in more detail (Ivankova et al., 2006). Single-group pre-and post-test model, which is one of the weak experimental designs, was used for the implementation of the research. Experimental designs are based on holding all conditions and variables constant except the independent variable in the process of the research and examining the effect it has on the experimental group (Ross & Morrison, 2004). A single group pre-test-post-test model was used to obtain the quantitative data of the study. This model is used to compare groups and to determine the change resulting from the experimental intervention (Büyüköztürk et al, 2016). Interview technique was used to obtain qualitative data. Interviewing is an indispensable and important data collection technique in social sciences research (Briggs, 1986). People are provided with information about their own feelings, attitudes and experiences through interviews (Türnüklü, 2000).

#### *Data collection*

“Entrepreneurship Scale for Middle School Students” developed by Özcan (2019) was used in order to collect the quantitative data of the study. This scale was a five-point Likert-type one including strongly agree, agree, don’t know, disagree and strongly disagree choices and applied to students before and after the experimental application. A semi-structured interview consisting of seven questions in parallel with the items in the sub-dimensions of the entrepreneurship scale was also applied before and after the application for the purpose of obtaining the qualitative data and the interview questions were asked to determine the entrepreneurial skill levels of the students. The interview questions which were asked to determine entrepreneurial skills and their relevant sub-dimensions (self-confidence, the perception of innovation and creativity, leadership and tendency to stand out, social skills and group work, risk taking tendency) are as follows:

- (1) “Can you freely share your opinion you think is correct with your friends?” “self-confidence”.
- (2) “What is it like for you to stand out during group work?” “Leadership and tendency to stand out”.
- (3) “What do you think about group leadership?” “Leadership and tendency to stand out”.

(4) “Can you find creative solutions to the problems you face?” “the perception of innovation and creativity”.

(5) “Do you feel like you are doing wrong while determining your ideas or decisions?” “Self-confidence”.

(6) “What do you think about group work with friends?” “Social skills and group work”.

(7) “Can you take risks in situations that you think are important?” “Risk taking tendency”.

#### *Data Analysis*

“Paired samples t test” which is one of the statistical methods was used for the analysis of quantitative data. Paired samples t-test is an analysis method used in the application of a test-retest situation and in the process for investigating the relationship or the level of difference between pre-test and post-test scores (Mee & Chua, 1991). Qualitative data were analyzed by using the “content analysis method”. Content analysis provides the researcher with the opportunity to analyze data with an impressionist, instinctive and interpretative approach (Hsieh & Shannon, 2005). Applications in the studies conducted by Maxwell (1992), Lincoln and Guba (2000), Creswell and Miller (2000) were used in order to validate the qualitative measurement tools and the analysis of the research. According to these studies, in order to ensure the validity of the qualitative measurement tools, it was ensured that the study group gave sincere and correct answers to the questions. The interviews were recorded and transformed into written texts in order that the researcher could objectively quote the answers given to the questions. In this context, measurement tools were examined by professionals in the field of educational sciences, and the questions in the measurement tool were finalized by taking into consideration the opinions of the experts.

#### *Validity and Reliability*

Şencan (2005) have stated that validity is a concept used to determine to what extent the questions in the measuring tool represent the characteristics aimed to be measured. In this respect, the qualitative data of this research represent the characteristics that are aimed to be measured as they are prepared in accordance with the sub-dimensions of the entrepreneurship scale. Moreover, in order to ensure the reliability of the qualitative data of the research, codes and categories determined independently by two different researchers were created and compared within the scope of the content analysis. The number of consensus and disagreement was determined and the reliability of the study was ensured. The reliability coefficient was determined according to the formula ( $\text{Reliability} = (\text{Agreement} / (\text{Agreement} + \text{Disagreement}) \times 100)$ ) developed by Miles and Huberman (1994). The reliability coefficient

determined in this study was found as 91%  $[(42 / 42+5) \times 100]$  for the interview questions prepared for entrepreneurial skills.

### *Implementation*

STEM education was given to the students in the experimental group for 8 weeks by the applications involving entrepreneurship-based STEM activities each week within the scope of the application process. Research data were collected by using qualitative and quantitative measurement tools. The studies on the entrepreneurship-based STEM education were examined and the STEM activities were performed by considering the developmental levels and readiness of the experimental group. The “E-STEM” model which was discussed and explained by Deveci in the book called “STEM Education from Theory to Practice” was taken as basis in the application steps of the activities that are economical in terms of time and cost. In this regard, the acquisitions for “the catapult” activity were determined under the name of “Science, Engineering and Entrepreneurship Practices” and the necessary theoretical information about this activity was provided to the students. Then, they were expected to define the problem by associating it with a need in daily life. A discussion and brainstorming environment was created, for instance; “Let’s assume there is a problem such as throwing an object away. So how would we deal with this problem?”. Afterward, students were given the chance to answer the question “What kind of design can we develop to solve this problem?” and subsequently, they were asked to choose the simple materials with which they could model this design. Each group of students discussed how effective the work was in solving the given problem by designing their joint work, and also the questions “What variables must be changed?” (For example, if the rubber bands are wrapped more in the tongue bar, can the object be thrown further? etc.) were asked by the students and they argued on which principles of STEM fields they used to develop this work. Finally, students were asked to compete and market their work for the purpose of putting more emphasis on their entrepreneurial skills.

## **Findings**

### *The Analysis of Quantitative Data*

The quantitative data of the study were analyzed by statistical methods. It was observed that the obtained quantitative data were normally distributed by considering Shapiro-Wilk test due to the fact that the sample number was below 50 (Razali and Wah, 2011). According to the Shapiro-Wilk test, A p-value higher than 0.05 ( $> 0.05$ ) indicates that the data group is normally distributed (Taşpınar, 2017). The pre-and post-test results of the “Entrepreneurship

Scale for Middle School Students” and its sub-dimensions applied to 20 students before and after the activity were analyzed with the “Paired Sample t-test” method. The findings obtained are shown in Table 1 and Table 2.

Table 1. Results of the Paired Sample t-Test on entrepreneurship scale

Measurements	N	$\bar{x}$	Sd	T	df	P
Pre-test	20	96.95	19.10215	-	19	.107
				1.692		
Post-test	20	107.20	17.67127			

The paired sample t-test results of the pre-and post-test scores of students' entrepreneurial skills are shown in Table 1. Paired samples t-test was conducted to determine whether there was a significant difference between pre-test and post-test scores. Since the significance level was higher than 0.05 ( $p > 0.05$ ), no significant difference was found between pre-and post scores.

Table 2. Results of the Paired Sample t-Test for the sub-dimensions of the entrepreneurship scale

Sub-dimension	Measurement s	N	$\bar{x}$	Sd	T	df	P
Self-confidence	Pre-test	20	16.45	6.39469			
					-.575	19	-.572
The perception of innovation and creativity	Pre-test	20	22.35	5.8063			
					-.434	19	.669
Leadership and tendency to stand out	Pre-test	20	21.5	3.85937			
					-.862	19	.400
	Post-test	20	22.5	2.74341			

Social skills and group work	Pre-test	20	24.15	4,35618		
					-1.663	19
	Post-test	20	26.25	4.15331		
Risk taking tendency	Pre-test	20	15.85	4.53379		
					-1.228	19
	Post-test	20	17.70	4.71392		

The paired sample t-test results of the pre-and post-test scores of the students' entrepreneurial skills are shown in Table 2. Since the significance level is higher than 0.05 ( $p > 0.05$ ) for each sub-dimension, it can be stated that there is no significant difference between pre-post scores.

#### *The Analysis of Qualitative Data*

The qualitative data of the study were analyzed by the content analysis method. In this context, codes and categories were created for the answers to the 7 questions that were asked in order to measure the entrepreneurial skills of the students, and the frequency and percentage rates of these codes were shown as pre-and post-test along with the necessary explanations given under the tables.

Table 3. Student views on the first question

Category	Code	Pre-test Frequency (F)	Post-test Frequency (F)	Pre- Test (%)	Post- test (%)
Yes	Freely	1	4	5	20
	Directly	12	12	60	60
	Unsure	1	1	5	5
No	Fear	1	0	5	0
	Hesitation	5	3	25	15
Total		20	20	100	100

In Table 3, the answers to the question “Can you freely share your opinion you think is correct with your friends?” consisted of two categories called yes and no, and 5 five codes (freely, directly, unsure, fear, hesitation). The category of yes consisted of codes that are called freely, direct, unsure. The frequency value of the code called “freely” increased in

favor of the post-test, while frequency values did not change in other codes in this category. The codes in this category were composed of the thoughts that students could freely or directly express their ideas even if they were not sure that they were correct. The category of no consisted of the codes that are called fear and hesitation. The frequency values of these codes decreased in favor of the post-test. The codes in this category comprised of the thoughts that the students were afraid of expressing their ideas freely and they avoided expressing their thoughts because of being a person with a timid personality or assuming that they would feel embarrassed about expressing opinions, asking questions about the point they do not understand, and thinking that they would be ridiculed by their friends. Some of the students' thoughts are given below:

*S1: "...I can express my ideas, even when I am not sure..."*

*S2: "...No, I can not. Because, I feel afraid of being mocked if I am wrong..."*

Table 4. Student views on the second question

Category	Code	Pre-test Frequency (F)	Post-test Frequency (F)	Pre- Test (%)	Post- test (%)
Liking	Pleasant	10	13	50	65
Disliking	Timidity	8	5	40	25
	Unassociated	2	2	10	10
Total		20	20	100	100

According to Table 4, the answers to the question "What is it like for you to stand out during group work?" consisted of two categories called liking and disliking, and three codes (pleasant, timidity, unassociated). The category of liking consisted of a single code called pleasant. The frequency value of the code called "pleasant" increased in favor of the post-test. This code was composed of the thoughts that students liked to stand out during group work and they did not hesitate to stand out. The category of disliking consisted of the codes that are called timidity and unassociated. The frequency value of "timidity" decreased in favor of the post-test while the frequency level of "unassociated" remained stable. The codes in this category comprised of the thoughts that students could not highlight themselves and prefer to stay in the background. Moreover, students stated that many disagreements could arise during group work, they could more freely make their own decisions, they did not prefer to make

decisions on behalf of the group, also they did not want to take the responsibility of their groupmates. Some of the students' thoughts are given below:

S3: "...I don't like standing out as a single person..."

S4: "...I got used to standing out thanks to the activities..."

Table 5. Student views on the third question

Category	Code	Pre-test Frequency (F)	Post-test Frequency (F)	Pre- Test (%)	Post- test (%)
Affective	Liking	6	10	12	20
	Desire	6	10	12	20
	Disliking	14	10	27	20
	Hate	14	10	27	20
Self- efficacy	Ability	1	3	2	5
	Disability	10	8	20	15
Total		51	51	100	100

In Table 5, the answers to the question "What do you think about group leadership?" consisted of two categories called affective and self-efficacy, and six codes (liking, desire, disliking, hate, ability, disability). The category of affective consisted of codes that are called liking, desire, disliking, hate. The frequency value of these codes remained unchanged. The codes in this category were composed of the thoughts that some students loved and played a role in group leadership, while some of them did not like leadership because they could not highlight themselves within their group, and also the students preferred group leadership because they liked to organize. The category of self-efficacy consisted of the codes that are called ability and disability. The frequency values of these codes changed in favor of the post-test. The codes in this category comprised of the thoughts that some students' personality were not agreeable for group leadership because these students could not bring themselves to the fore and group leadership is not a responsibility that they could take because of the fact that they did not trust themselves in controlling the group and also some students believed that they were able to lead the group through the activities. Some of the students' thoughts are given below:

S5: "...I don't prefer to be a group leader, it's not something easy for me..."

S6: "...I don't want to be a group leader because I don't want to take that responsibility..."

Table 6. Student views on the fourth question

Category	Code	Pre-test Frequency (F)	Post-test Frequency (F)	Pre- Test (%)	Post- test (%)
Yes	Comprehension	3	3	12	10
	Test questions	2	2	8	6
	Relationships	5	5	19	16
	Technical problems	8	8	30	26
	Demanding help	5	5	19	16
	STEM activities	0	5	0	16
No	Disability in problem solving	3	3	12	10
Total		26	31	100	100

In Table 6, the answers to the question "Can you find creative solutions to the problems you face?" consisted of two categories called yes and no, and seven codes (comprehension, test questions, relationships, technical problems, demanding help, STEM activities, disability in problem solving). The category of yes consisted of codes that are called comprehension, test questions, relationships, technical problems, demanding help, STEM activities. The frequency values of the codes remained unchanged except for the code "STEM activities". The frequency of the code "STEM activities" increased in favor of post-test. The codes in this category were composed of the thoughts that students could solve problems that arise within the family of friends' circle or in technological devices and also they could cope with problems by receiving help from others. In addition, they could solve problems about doing homework, tests or about mathematical problems. Some students were able to repair broken devices at home, whereas a couple of students used internet search to solve their problems. Apart from the most students, five students stated that they encountered and solved some problems during the implementation of the activities. The category of no consisted of the code

“disability in problem solving”. The frequency values of this code remained equal. The codes in this category comprised of the thoughts that students could not figure out the right way of problem solving, even though they tried to solve the problem and they could not think of any creative solutions because they only focused on the problem instead of its solution. Some of the students’ thoughts are given below:

S7: “...I designed the parachute using balloons during a STEM activity and it worked...”

S8: “...My solution never works whenever I try to solve a problem...”

Table 7. Student views on the fifth question

Category	Code	Pre-test Frequency (F)	Post-test Frequency (F)	Pre- Test (%)	Post- test (%)
Yes	Strongly yes	9	9	45	45
	Sometimes	5	5	25	25
No	Strongly no	6	6	30	30
Total		20	20	100	100

In Table 7, the answers to the question “Do you feel like you are doing wrong while determining your ideas or decisions?” consisted of two categories called yes and no, and three codes (strongly yes, sometimes, strongly no). The category of yes consisted of codes that are called strongly yes and sometimes. The frequency values of the codes remained unchanged. According to the statements of this category, some students were not certain in decision making because of feeling as though their decisions were wrong. These students also stated that they felt like they were wrong while answering a question. The category of no consisted of the code “strongly no”. The frequency values of this code also remained the same. The codes in this category comprised of the thoughts that students were mostly satisfied with the decision they make, they did not feel like they were making a wrong decision because they generally trusted in their decision, and they had the right information about their ideas. Some of the students’ thoughts are given below:

S9: “...I sometimes feel like I give wrong answers to the questions in the classroom...”

S10: “...I am usually confident with the decisions I make...”

Table 8. Student views on the sixth question

Category	Code	Pre-test Frequency (F)	Post-test Frequency (F)	Pre- Test (%)	Post- test (%)
Affective	Liking	8	15	36	57
	Disliking	8	2	36	8
	Inconstancy	4	3	18	12
	Timidity	1	1	5	4
Self- efficacy	Suitability	1	5	5	19
Total		22	27	100	100

In Table 8, the answers to the question “What do you think about group work with friends?” consisted of two categories called affective and self-efficacy, and five codes (liking, disliking, inconstancy, timidity, suitability). The category of affective consisted of codes that are called liking, disliking, inconstancy, timidity. The frequency values of the codes changed in favor of post-test, while the code of “timidity” remained unchanged. According to the statements of this category, students liked and felt better in group work after the implementation, and also they liked learning more because they had fun with their friends. Moreover, they could get help from their friends when they had difficulty while alone, besides they could share their information. They could also finish their homework or task in a shorter time. On the other hand, it was also stated that some students did not like group work because there might be disagreement within the friends, and also they did not prefer group work because their ideas were not welcomed by their friends. The category of self-efficacy consisted of the code “suitability”. The frequency values of this code also changed in favor of post-test. The codes in this category comprised of the thoughts that students found group work suitable for them, and realized that they could overcome this situation after the implementation, although they were biased and timid about group work with their friends. Some of the students' thoughts are given below:

*S11: “...I sometimes like group work depending on the situation...”*

*S12: “...I prefer individual work because I think that the decision of a single person is more logical than a group decision...”*

Table 9. Student views on the seventh question

Category	Code	Pre-test Frequency (F)	Post-test Frequency (F)	Pre- Test (%)	Post- test (%)
Yes	Usually	10	10	50	50
	Sometimes	4	4	20	20
	Rarely	2	2	10	10
No	Never	4	4	20	20
Total		20	20	100	100

In Table 9, the answers to the question “Can you take risks in situations that you think are important?” consisted of two categories called yes and no, and four codes (usually, sometimes, rarely, never). The category of yes consisted of codes that are called usually, sometimes and rarely. The frequency values of these codes remained stable. According to the statements of this category, students generally thought that they did not have any problems on risk taking, in other words, they did not refrain from taking risks as long as they could bear the consequences. Some of them sometimes took risks when the situation was important and some students rarely took risks. The category of no consisted of the code “never”. The frequency values of this code also remained unchanged. The codes in this category comprised of the thoughts that students did not like to take risks at all or they were not inclined to take risks because it might be dangerous. So they never thought of taking risks. Some of the students’ thoughts are given below:

*S13: “...I wouldn't take any risks because it might be dangerous ...”*

*S14: “...I rarely take risks as it might cause bad consequences ...”*

### Conclusions and Suggestions

In this study, middle school students’ entrepreneurial skills were investigated in terms of the entrepreneurship-based STEM education. Based on the results obtained from the quantitative data of this research, an increase was observed in favour of the post-test, although the overall increase was not statistically significant and also, according to the results obtained from the qualitative data, it was observed that the E-STEM activities contributed to the students’ ability to work in groups, to stand out and leadership skills. In other words, the data obtained from the interviews indicated that E-STEM activities had a positive effect on the

sub-dimensions of entrepreneurial skills called “leadership and tendency to stand out”, “social skills and group work” and “the perception of innovation and creativity”.

Many studies emphasize that one of the main goals of STEM education is to develop entrepreneurial skills (Guerra et al., 2014; O’Leary, 2012; Deveci, 2019; Caldwell et al., 2018; Rae & Melton, 2017; Camesano et al., 2016). Likewise, the quantitative and qualitative results of this research indicate that E-STEM education is a contributing factor that positively affects students’ entrepreneurial skills. This result raises the question of which factors play a key role in the development of the entrepreneurial skills. Many studies have been trying to find an answer to the question of what factors have an impact on entrepreneurship. Stone et al. (2013) point out that among the factors affecting entrepreneurial tendency, cultural and ethnic origin plays a crucial role besides the social environment. In addition, this study clearly stated that the experimental studies in this field did not yield adequate results for a common idea or generalization. Tur-Porcar et al. (2018) have suggested based on their research findings that behavioral factors and ethical values are among the most important factors affecting sustainable entrepreneurship. According to these studies, it can be concluded that the development of entrepreneurial skills can not be affected only by an education programme or activity, genetic and environmental factors are also decisive in causing a sharp change. Considering the results of this study, the fact that the implementation period of the activities was limited to eight weeks may also be an impediment to a significant increase.

Some sub-dimensions and skills are crucial for the determination of entrepreneurial skills (Özcan, 2019). Considering the quantitative analysis on one of these sub-dimensions called “leadership and standing out”, it was observed that the number of the students who liked leadership and standing out increased in favor of post-test. Students could take the opportunity to stand out and to act as a group leader and these experiences might have caused this behavioral change. The qualitative results support the quantitative analysis results of this sub-dimension. The fact that some of the students stated that they liked to thrust themselves forward in the group indicates that they used group work as a means to reveal their entrepreneurial characteristics. Some students who stated that they did not like to bring themselves to the forefront after the implementation or did not want to take organizing roles in group work changed their minds. Even partially, the activities had a positive effect on these skills of the students. The main reason for this result is that the students worked in groups during the activities and this process helped them discover leadership skills and reduce their prejudices. According to the analysis of quantitative data, although there is an increase in the

leadership sub-dimension in favor of the post-test, this increase did not cause a significant change. Before the implementation, a significant portion of the students stated that leadership was not suitable for them or their organizational skills were not good, but after the implementation, some students stated that they believed that they could lead and organize the group. This result also partially supports the quantitative data. Therefore, it can be stated that the activities have a partially positive effect on the leadership tendencies of the students. The possible reason for this effect may be that leadership is influenced by experiences as well as personal characteristics. It can be claimed that students have gained an experience by leading the group, expressing their opinion, working collaboratively. Besides, this situation can be an indication that the concepts of leadership, standing out and entrepreneurship are interrelated.

Considering the quantitative analysis results of the sub-dimension called “the perception of innovation and creativity”, an insignificant increase in favor of the post-test was observed. According to the answers obtained from the interview before the implementation, it was seen that most of the students could solve problems in at least one field. Among these fields, technical and social problems mostly stood out. After the implementation, some students gave examples of STEM-related problem solving in addition to the other fields. Students encountered problems during the applications of E-STEM activities and made an effort to solve the STEM-related problems. Therefore, in addition to the codes in the pre-test, during the post-test interview, the students stated that they could solve problems also in the field of STEM. At this point, it can be stated that the E-STEM activities contributed to the problem solving skills of some students. İnce et al. (2018) investigated the effect of STEM activities on children’s problem solving skills and concluded that STEM activities had a positive effect on their children’s problem solving skills. In addition, many studies have emphasized that STEM activities can positively affect problem solving and creativity skills also in a theoretical framework (Brown et al., 2011; Madden et al., 2013; Kelley & Knowles, 2016).

The concept of self-confidence which is another sub-dimension of entrepreneurial skills is described as the ability to express ideas and being decisive in the qualitative data. As a result, students’ answers on being self-confident did not change significantly after the implementation. However, the answers given to the question about freely expressing their opinions positively increased. Students generally felt that their answers were wrong about solving the questions related to the course subjects. However, some students stated that they stood behind their decisions and trusted their own ideas. Based on this result, it can be inferred that the activities did not have a considerable effect on students’ decisiveness in their

opinions or decisions. Clifton and Gill (1994) have claimed that the concept of self-confidence is a psychological feature and they found supportive results in their study on the factors affecting self-confidence, also arguing that personal characteristics such as gender and perfectionism affect self-confidence.

According to the analysis of the thoughts about the fourth sub-dimension called “group work”, it can be inferred that the qualitative and quantitative data results for this sub-dimension also support each other. It is also observed that there is a positive difference in students' views on group work. Many students who have prejudices about group work before the application of the activities, it was concluded that they actually enjoyed and managed to actively participate in the group work. It can be argued that the contribution of STEM activities in this result is obvious. The group studies experienced by the students within the scope of STEM activities positively changed the views of a significant portion of their students about group work. Likewise, in the studies conducted by Akdağ and Güneş (2017), Dönmez (2017), Akgündüz and Akpınar (2018), it was concluded that the STEM activities carried out with group studies contributed to the students' enjoyment of group work and collaboration.

There was an insignificant increase in favor of the post-test in the quantitative analysis of the final sub-dimension called “risk taking tendency”. However, according to the qualitative data regarding risk taking, it was determined that the pre-and post-test frequencies of the answers did not change and the majority of the students were more or less risk-takers. Therefore, considering the qualitative results, STEM activities did not have an effect on students' risk taking tendency. On the other hand, according to the quantitative results, it can be claimed that the activities have an insignificant effect on this tendency. Bang (2000), has emphasized that the most important risk-taking factors are socio-cultural factors; such as age, gender, education level, and also in the study conducted by Saraç and Kahyaoğlu (2011) it has been revealed that socio-economic factors affect risk taking tendency. To sum up the results on these factors, similar studies indicate that risk-taking tendency is affected by many different factors and most of them are not caused by short-term environmental interventions. In fact, long-term variables and characteristics play a much more effective role on risk-taking behavior.

There may be many reasons why middle school students' entrepreneurial skills did not change significantly via STEM activities. Moreover, the studies pointed out that entrepreneurship is multidimensional, the factors affecting entrepreneurship are variable and

numerous, the effect of the environmental factors, family and characteristics cannot be easily changed (Sharma & Madan, 2014; Kaygın & Güven, 2015; Fahed-Sreih et al., 2010). In addition, it can be asserted that the limited duration of the activities is a factor that prevents the change or development of entrepreneurial skills. Moreover, considering the pre-test data, the fact that the entrepreneurial characteristics of the participant group were not very low before the implementation is a factor that may cause this result. Consequently, the most comprehensive result that can be deduced that the STEM activities mostly affect the students' feelings and views on the concepts of group work, leadership, and standing out. Another result of the study is that activities did not play a significant role in characteristics and skills such as self-confidence and risk taking. Based on the increase in the post-test results of the process, which is limited to eight weeks, it can be predicted that this increase can be significant, provided that a much longer STEM application process is conducted. Based on this research, it is recommended to investigate the effects of other factors and educational approaches on entrepreneurial skills for future studies to be conducted on this subject. Besides, sub-dimensions of entrepreneurial skills can be discussed in more detail. The E-STEM implementation was carried out at the middle school level. However, this implementation can be replicated on students at other education levels. Finally, The implementation period can be kept longer to ensure a significant effect.

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## Ortaokul öğrencilerinin girişimcilik becerilerinin Girişimcilik Temelli STEM Eğitimi Açısından İncelenmesi: Karma yöntem çalışması

### Özet:

Bu çalışma ortaokul öğrencilerinin girişimcilik becerilerini E-STEM eğitimi açısından araştırmak amacıyla yapılmıştır. Araştırmanın evrenini kırsal kesimdeki ortaokul öğrencileri oluşturmaktadır. Tek grup ön ve son test deseninin kullanıldığı araştırmanın örneklemini 20 sekizinci sınıf öğrencisi oluşturmuştur. Araştırmada karma yöntem tercih edilmiştir. Nicel verileri elde etmek için girişimcilik ölçeği kullanılmıştır. Nitel verilerin elde edilmesi için yarı yapılandırılmış görüşme formu kullanılmıştır. Öğrencilere 8 hafta boyunca E-STEM eğitimi verilmiştir. Nicel verilerin ön ve son test ortalamaları bağımlı örneklem t testi ile karşılaştırılmış ve nitel verilerin analizinde içerik analizi yöntemi kullanılmıştır. Sonuç olarak, öğrencilerin girişimcilik becerileri ve girişimcilik alt boyutlarına ait puanları genel artış anlamlı olmasa da son test lehine yükselmiştir. Ayrıca nitel verilere göre E-STEM etkinliklerinin alt boyutlara olumlu etkisi olduğu görülmüştür. Anahtar kelimeler: girişimcilik, ortaokul öğrencileri, STEM etkinlikleri

Anahtar kelimeler: 3 to 5 key words in Turkish, lowercase, comas between the key words.

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