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Examining of STEM Motivations and Entrepreneurship Levels of Pre-Service Teachers

Mustafa Tüysüz [1] Ümmüye Nur Tüzün [2] Elif Selcan Öztay [3] Gülseda Eyceyurt Türk [4]

[1] Van Yüzüncü Yil University, Faculty of Education, Department of Science Education, Van, Turkey, mustafatuysuz@yyu.edu.tr

[2] Ministry of National Education, Ankara, Turkey, u_tuzun@hotmail.com

[3] Van Yüzüncü Yil University, Faculty of Education, Department of Chemistry Education, Van, Turkey, selcankutucu@yyu.edu.tr

[4] Sivas Cumhuriyet University, Faculty of Education, Department of Chemistry Education, Sivas, Turkey, gulsedaeyceyurt@gmail.com

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ABSTRACT

The purpose of the current research was to highlight the STEM motivation and entrepreneurship skills of pre-service teachers educating on different programs. For this purpose, the quantitative research approach was conducted, and a survey model was employed. The sample of this research comprised 285 pre-service teachers enrolled in the various departments of faculty of education in a state university in Türkiye. "Entrepreneurship Scale for Teacher Candidates" and "STEM Motivation Scale" were utilized as data collection tools. It was found statistically significant differences between early childhood education and elementary mathematics education, between elementary education and elementary mathematics education, and also between science and elementary mathematics education in favour of elementary mathematics education regarding the mean scores of pre-service teachers' mathematical motivation (MM) in the significance level of .05. It was also found that there was a significant difference between elementary education and elementary mathematics education in favour of elementary education regarding the mean scores of pre-service teachers' self-confidence (SC) in the significance level of .05 in Entrepreneurship Scale for Pre-service Teachers. Also, it was found that there was a significant difference between elementary education and elementary mathematics education in favour of elementary education regarding the mean scores of students' emotional intelligence (EI) in the significance level of .05 on the Entrepreneurship Scale for Teacher Candidates. According to the results, further implementation suggestions were given.

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INTRODUCTION

There is globalisation all over the world, so for a long time countries have competed with each other in science and technology to improve their economic situation. Constructing or revising new scientific knowledge would give occasion to much better and more advanced technologies, whereas using the latest technologies would cause further and upper metacognitive scientific knowledge constructions or revisions. This is a circle making countries compete with each other in science, technology, and so in an economy that would make countries bring up qualified citizens competing in job markets. For bringing up eligible citizens to compete in job markets, there have been new trends in educational policies, especially in the last few decades, namely STEM education. These innovative or adapted recent educational policy trends require bringing up students from all academic levels with high metacognitive abilities, especially being able to integrate and use scientific, technological, engineering, and mathematical (STEM) knowledge and gaining entrepreneurship thinking (Tozlu et al., 2019; Turgutalp, 2021).

STEM education is an approach that has come to the fore in the international discourse in the fields of education, manufacturing, revelation, and competition. (Marrero et al., 2014). STEM-based education has been receiving increasingly greater importance and attention worldwide (Aydin-Gunbatar et al., 2020) due to the need to train citizens enriched with 21st century skills such as offering solutions to problems, effective interactions, collaboration and creative thinking. STEM education is essential to increase students' STEM interests and career motivation in STEM fields (Miller & Roehrig, 2018). In STEM education, instead of integration, a more plausible philosophy could be adapted to demonstrate detailed, robust, and appropriate links between STEM disciplines by using constant interactions with a daily-life domain (Williams, 2011). Hence, STEM philosophy is a map to make students learn more connected (Stohlmann et al., 2012).

STEM education is a meta-discipline, a multidisciplinary effort that goes beyond science, technology, engineering and mathematics subjects. Instead, it focuses on the innovative process of constructing solutions to complex daily-life problems using innovative technologies. Engaging students from all educational levels in qualified STEM education needs educational programs including objectives focusing on STEM education, alternative instructional strategies, and alternative assessment methods by relating technology and engineering disciplines to the science and mathematics curriculums and also by increasing scientific inquiry, scientific reasoning, scientific argument construction, entrepreneurship skills and the engineering design processes. Hence, during teacher education programs, pre-service teachers should experience STEM-based education and learn how to conduct STEM education in the classrooms to guide their future students in achieving STEM literacy (Kennedy & Odell, 2014).

Researchers defined STEM education in different domains in literature. For an illustration, Moore et al. (2014) determined the STEM education as a philosophy to relate more STEM disciplines into a lesson focused on real-world issues. Similarly, according to Kelly and Knowles (2016), STEM education should include two or much more STEM disciplines. The STEM education interdisciplinary nature requires a multidisciplinary approach, interactions among contents, connected learning targets, skills, concepts, and skills in specific fields, integrating at least two or much more STEM disciplines. STEM education also requires problem-based learning, project-based learning, meaningful learning, motivating, enjoyable, engaging context domains, defining, formulating, evaluating, and solving problems, and open-ended, accurate word, authentic problems (Rosicka, 2016). Constructing questions, carrying out inquiries, analyzing gathered data, interpreting the findings and utilizing authentic processes are also needed. Students must benefit from using models, designing solutions, engineering-based designing prototypes, justifying the designs, and/or learning from failures and redesigning based on that learning. Collaborative learning, communication in groups, group work, student-centred pedagogies, and hands-on activities are needed through the STEM education processes. Highlighting student misunderstandings, integrating assessment in instruction, utilizing alternative assessments, employing reflective writing, and considering the previously learned concepts are the factors that must be considered through the assessment process of STEM education. By this way, instruction integrated with STEM education create an opportunity to gain 21st century skills (Tytler, 2020). “Entrepreneurship” is one of 21st-century skills included in the category of “career and life skills” (Trilling & Fadel, 2009). Science, technology, engineering, and math (STEM) education has a lot in common with 21st-century society in that it is an educational model that allows people to learn how to do business and work together, as well as how to develop high-quality skills namely entrepreneurial and team work skills (Walan, 2021). Entrepreneurship skills refer to individual investment and focus on the personal benefit to the efforts at getting work done through risk-taking to satisfy human wants. Thus, a person with operative entrepreneurship skills understands their environment people's needs, takes a risk to solve persistent problems, sets solutions in motion for solving the issues, has foresight about the probable risks, and searches for success. Then entrepreneurship skills gaining based education would make students for their future life being able to manage small and medium enterprises, be innovative and creative in their jobs, being able to access funds for solving problems and contribute to the global economy on the scale of their employment (Dumebi-Moemeke, 2013). In literature, entrepreneurship skills gained based on education made individuals take risks, see the opportunities, be innovative, and think emotionally (Deveci & Çepni, 2017). In addition, the use of the term "entrepreneur" under the heading of "life skills" in the new mid-school science curriculum shows that the objectives of the new program are in line with the STEM methodology (Deveci, 2016). Moreoever, Farwati et al. (2021) mentioned that teachers integrate STEM education into tehir instruction to develop students’ entrepreneurial skills and various 21st century skills. Hence, STEM education and entrepreneurship skills are closely related.

Motivation is defined as the intention of behavior (Elliot & Coverton, 2001). Considering studies conducted on motivation, it was found that there was a relationship between students’ motivation on learning and academic achievement (Linnenbrink & Pintrich, 2002; Schick & Phillipson, 2009). In literature, STEM motivation was defined as the target to enhance students' motivation towards the STEM disciplines. The determination of students' motivation for STEM, as well as the maintenance of that interest, may be viewed as a significant factor in explaining their performance in STEM areas (Dönmez, 2020). Experimental designs were demonstrated to increase students' motivation towards STEM, and some of these efforts had positive effects whereas further studies were recommended (Rosenzweig & Wigfield, 2016). Starr et al. (2022) highlighted in their research that parents' STEM support caused an increase in students' STEM motivation. Cheng and her colleagues (2020) examined the influence of teachers' beliefs, and 3D modelling integration in teaching on students' science-technology-engineering and mathematics motivation. Finally, it was concluded that teachers' STEM integration ability predicted students' math motivation whereas teachers' beliefs and 3D modelling integration levels were not predictors (Cheng et al., 2020). Restivo et al. (2014) utilized augmented reality in teaching environments to improve students' STEM motivation, Starr et al. (2020) utilized authentic science practices to improve STEM motivation. In addition, Dönmez et al. (2022) utilized argumentation-based STEM activities for improving STEM motivation. To improve STEM motivation, Starr et al. (2019) utilized virtual reality experiences, where all the researches' differed teaching domains affected the research results positively. In the literature, there were also studies searching entrepreneurship education's effect on improving students' entrepreneurship skills. In Oosterbeek et al.'s (2010) research, the content was not appropriate for the previously determined targets: the impact on students' entrepreneurial skills was not meaningful, and the effect on planning to become an entrepreneur was also significantly not positive.

However, there are many impediments in STEM education, such as rigid school timetables and rigid curriculum targets, deficient teachers' awareness of STEM education and inadequate content knowledge of teachers to other subject areas, inflexible and unergonomic classroom designs, and insufficient assessment strategies. With a focus on STEM interaction rather than integration driven by teachers, interventions can be developed to overcome these impediments (Williams, 2011). This is likely if only teachers had enough awareness of STEM philosophy, enough multidisciplinary content knowledge, practical thinking, high metacognitive thinking skills such as entrepreneurship skills and the ability to use alternative assessment strategies. These mentioned characteristics could only be given to teachers through teacher education programs if only tutors in the education faculty were aware of pre-service teachers' previous STEM motivation, especially their entrepreneurship skills.

Significance of The Study

The main aim of the investigation is to determine the STEM motivation and entrepreneurship skills of pre-service teachers enrolled in different departments. As it is known, STEM education is explained as an integrated and interdisciplinary approach from kindergarten to 12th grade that focuses on the education of students in four disciplines (Bybee, 2010; Wang et al., 2011). Integrated STEM education should be started in preschool education to be more effective in increasing students' creativity (Üret & Ceylan, 2021). Also, early-age STEM education may lead students to gain knowledge and skill in STEM-related disciplines (Park et al., 2017). Unfortunately, one of the main themes in science education literature is the increasing unwillingness of students to participate in science, technology, engineering and mathematics (STEM) (Bøe et al., 2011; De Loof et al., 2021). Teachers have an essential role in implementing STEM education, so teacher education programs should train pre-service teachers in terms of implementing STEM education (Aydn et al., 2020). Teachers have difficulty implementing STEM in their courses due to a lack of knowledge (Wang et al., 2011) and motivation regarding STEM education (Abdullah et al., 2017).. Before becoming a teacher, teachers should equip pre-service teachers with STEM awareness and motivation for implementing STEM in their lessons. In order to increase students' motivation and engagement in STEM, it is important to investigate teachers' motivation towards STEM and their entrepreneurship skills. Also, entrepreneurial integrated STEM education would offer learners an interactive environment for communication, emotional needs, and learning analysis (Kaya-Capocci & Peters-Burton, 2023; Kaya-Capocci & Ucar, 2023). In the current study, we focus on the STEM motivation and entrepreneurship skills of preservice teachers who are STEM teachers in the future.

The related literature highlighted a need for further research and discussions on the knowledge, experiences, and backgrounds of teachers effectively teaching STEM education (Stohlmann et al., 2012). However, most of the STEM studies focused on a single point as achievement, motivation, conception etc. In the current research, being different from the literature, both STEM motivation and entrepreneurship skills of pre-service teachers enrolled in various departments were aimed to determine simultaneously to be able to make a much more detailed and connected interpretation based on the findings in order to allow teacher educators to construct STEM-based teaching environments for also improving pre-service teachers' entrepreneurship skills being aware of their pre-knowledge.

METHOD

Research Design

The quantitative research approach was conducted in the current research, and a survey design was employed. A survey design was used to investigate the views of a large group of people regarding a particular topic (Fraenkel & Wallen, 2006). A survey design was employed in the research with the aim of conducting a situational analysis of a broader sample group using questionnaires to determine the STEM motivations and entrepreneurial skills of prospective teachers studying in different departments. In quantitative research, researchers collect data by using surveys or interviews to explain the attitudes, opinions, behaviors, or characteristics of a population or a sample from the population to test hypotheses through statistical analysis of the responses to the questions (Creswell, 2009).

Participants

The sample of this research was comprised of 285 pre-service teachers enrolled in the departments of early childhood education, elementary education, science education, and elementary mathematics education programme in a state university in Turkey. Table 1 shows the frequency and distribution of the pre-service teachers. In Table 1, frequency was shown by f, and percentages by %. The population of the study comprises prospective teachers studying in STEM-related fields (science, mathematics, chemistry, physics, biology, elementary education, and preschool education) at state universities in Turkey. The sample of the research consists of students pursuing education in STEM-related fields, specifically preschool education, science education, mathematics education, and classroom teaching, at a state university in the Central Anatolia region. Non-probability sampling, specifically convenience sampling, was employed in the selection of the sample. Data were collected from teacher candidates on a voluntary basis, and no distinction was made based on the grade level, as teacher candidates did not take a specific course related to STEM or Entrepreneurship.

Table 1. *Frequency and percentage distribution of the pre-service teachers*

		f	%
Gender	Female	229	80.4
	Male	56	19.6
Departments	Early child education	63	22.1
	Elementary education	64	22.5
	Science education	79	27.7
	Elementary mathematics education	79	27.7
	Total	285	100.0

Research Instruments and Processes

This research used two scales to collect data: the "Entrepreneurship Scale for Teacher Candidates" and the "STEM Motivation Scale". "Entrepreneurship Scale for Teacher Candidates" was developed by Deveci and Cepni (2015), composed of 38 items and five sub-categories: risk-taking (7 item), emotional intelligence (8 item), confidence (7 item), seeing opportunities (9 item), and innovation (7 item). The Cronbach's alpha reliability coefficient of the scale was .77. The Cronbach's alpha reliability coefficient of the Entrepreneurship Scale for Teacher Candidates applied on the sample in which the study was found .805.

"STEM Motivation Scale" was translated from English into Turkish through appropriate methodology by Dönmez (2020). The scale included 25 items and four sub-categories: science (6 item), technology (7 item), engineering (5 item) and mathematics (7 item). The scale’s Cronbach's alpha reliability coefficient was .84. Moreover, the Cronbach's alpha reliability coefficient of the STEM Motivation Scale applied to the sample in which the study was found .807. Since the values obtained for both scales were close to the original value, they were used in the research as high-reliability scales.

Data Analysis

Statistical Package for Social Sciences (SPSS 26.0) program was employed for the gathered data. The descriptive and inferential statistical analyses were utilized to examine gathered data and interpret the findings. The demographic characteristics of the participants were obtained by using descriptive statistics. Moreover, the skewness and kurtosis values were utilized to explore the normal distribution of the data. One-way multivariate analysis of variance (MANOVA) was utilized to determine the differences between groups in this research. MANOVA is also utilized to determine whether multiple independent variables, alone or in combination, impact the dependent variables. In this research, it was preferred to use this analysis because there are nine dependent variables (including entrepreneurship and motivation sub-dimensions) and one categoric independent variable (four different disciplines). Instead of performing ANOVA for these dependent variables separately, MANOVA, which allows the dependent variables to be analyzed simultaneously, should be applied to reduce the Type I error rate (Tabachnick ve Fidell, 2013) and it was determined the relationships between variables with Pearson correlation analysis. This current research determined the significance level as $p<.05$.

Ethic

The necessary ethics committee permissions for the research were obtained from the Scientific Research and Publication Ethics Social Sciences and Humanities Ethics Committee of Cumhuriyet University with the decision dated 30.12.2021 and numbered 113051.

RESULTS

Assumptions of MANOVA Analysis

In this part, the procedures and the assumptions of MANOVA were explained because being able to perform this analysis, the assumptions were necessary. MANOVA had a series of assumptions. These were the level of independent and dependent variables, size of the sample, observation independency, normality, outliers, linearity and multicollinearity, and variance-covariance matrices' homogeneity.

Level of both dependent and independent variables

There must be two or more dependent variables, and their type of measurement should be interval or proportional. Also, there must be two or more groups containing independent variable. The measurement type of this variable should be categorical, and the groups should be independent (Mayers, 2013). This study had nine dependent variables: risk-taking (RT), emotional intelligence (EI), self-confidence (SC), seeing opportunities (SO), being innovative (BI), science motivation (SM), technology motivation (TM), engineering motivation (EM), and mathematics motivation (MM). Moreover, one categorical independent group included early childhood education (ECE), elementary education (EE), elementary mathematics education (EME), and science education (SE). Thus, these assumptions were satisfied.

Sample size

Generally, each group should have more samples than the dependent variable. In each cell the minimum participants number in the current research is nine. In the research, there were at least 63 students in each cell. Thus, the sample size was sufficient.

Independence of observation

Observations must be independent. That is, in each group or between the groups there must be no relationship (Pallant, 2005). In this study, this assumption was met as the groups consisted of students from different fields.

Normality

In MANOVA analysis, multiple normality should be sought among the assumptions. Still, this assumption could be tested by looking at the normality of the dependent variable in each independent variable group. When the number of observations is less than 29, the Shapiro-Wilks test is used, and when the number of observations is more, the Kolmogorov-Simirnov test is checked (Kalaycı, 2008). Thus, Kolmogorov-Simirnov test values were considered since the number of observations in this study was more than 29. In Table 2, it was seen that the p values obtained for some variables according to the Kolmogorov-Smirnow normality tests were less than .05.

Table 2. *Tests of normality*

		Kolmogorov-Smirnov[a]		
	Departments	Statistic	df	Sig.
SM	ECE	,130	63	,010
	EE	,165	64	,000
	EME	,160	79	,000
	SE	,098	79	,056
TM	ECE	,109	63	,060
	EE	,097	64	,200*
	EME	,113	79	,015
	SE	,109	79	,021
EM	ECE	,101	63	,179
	EE	,118	64	,027
	EME	,116	79	,010
	SE	,095	79	,078
MM	ECE	,098	63	,200*
	EE	,129	64	,010
	EME	,123	79	,005
	SE	,130	79	,002
RT	ECE	,122	63	,021
	EE	,161	64	,000
	EME	,089	79	,188
	SE	,131	79	,002
SO	ECE	,133	63	,008
	EE	,186	64	,000
	EME	,158	79	,000
	SE	,183	79	,000
SC	ECE	,182	63	,000
	EE	,143	64	,002
	EME	,103	79	,036
	SE	,093	79	,086
EI	ECE	,151	63	,001
	EE	,135	64	,005
	EME	,103	79	,038
	SE	,133	79	,001
BI	ECE	,126	63	,015
	EE	,121	64	,021
	EME	,082	79	,200*
	SE	,118	79	,009

Hence, according to skewness and kurtosis values, the scores' distribution normality must be checked with univariate analysis. Theoretically, skewness and kurtosis values must be equal to zero (Tabachnick & Fidell, 2007) whilst Field (2009) previously determined that skewness and kurtosis values could be among -2 and +2 for normal distribution. Values given in Table 3 below were generally between +1 and -1 values. Thus, this assumption is likely met.

Table 3. *Skewness and kurtosis values*

D. Variables	Departments	Skewness	Std. Error	Kurtosis	Std. Error
SM	ECE	-,490	,302	,937	,595
	EE	-,550	,299	-,051	,590
	EME	-,415	,271	-,206	,535
	SE	,002	,271	-,364	,535
TM	ECE	-,063	,302	-,824	,595
	EE	,022	,299	-,298	,590
	EME	-,044	,271	,001	,535
	SE	,033	,271	-,202	,535
EM	ECE	,293	,302	-,710	,595
	EE	,542	,299	,121	,590
	EME	,203	,271	-,818	,535
	SE	,202	,271	-,836	,535
MM	ECE	,203	,302	-,286	,595

	EE	-,452	,299	-,073	,590
	EME	-,266	,271	-,837	,535
	SE	,289	,271	-,754	,535
RT	ECE	,094	,302	,098	,595
	EE	,723	,299	,065	,590
	EME	,113	,271	,234	,535
	SE	,205	,271	-,536	,535
SO	ECE	,288	,302	-,351	,595
	EE	,991	,299	1,341	,590
	EME	,116	,271	,766	,535
	SE	,400	,271	,051	,535
SC	ECE	,719	,302	,114	,595
	EE	,435	,299	-,376	,590
	EME	-,083	,271	-,321	,535
	SE	,220	,271	-,019	,535
EI	ECE	,146	,302	,217	,595
	EE	,523	,299	,293	,590
	EME	-,140	,271	-,235	,535
	SE	,121	,271	-,536	,535
BI	ECE	-,268	,302	,135	,595
	EE	-,241	,299	,931	,590
	EME	-,220	,271	-,229	,535
	SE	,296	,271	,515	,535

Then, to see variance-covariance matrices in groups are equal or not, Box's test of equality of covariance matrices must be analyzed to validate the multivariate normality. If the matrices are equal, the statistic is non-significant. As could be seen in Table 4, for this study, Box’s test significance values (p= .868) were more meaningful than the alpha level (.05). Also, the covariance matrices were nearly equal to each other since the statistic was non-significant for this study. Hence, the multivariate normality assumption was provided too.

Table 4. *Box’s test of equality of covariance matrices*

Box's Test of Equality of Covariance Matrices[a]	
Box's M	123,952
F	,866
df1	135
df2	159692,190
Sig.	,868

Outliers

An important essential assumption was outliers for MANOVA analysis since the analysis was susceptible to univariate and multivariate outliers. Therefore, it must be investigated the univariate and multivariate outliers. It is accepted for the univariate outliers that "there are cases (one or more) with exemplifying extreme value on one variable" (Tabachnick & Fidell, 2007, p.73). According to the findings, it was needed to highlight whether the outliers had a meaningful effect on the average. Thus, all continuous variables’ data are used to standardize scores (z-scores), and then "if the z-scores are higher than +3.29 or lower than -3.29, these cases are the potential outliers" (Tabachnick & Fidell, 2007, p.73). The findings of all variables' minimum and maximum z values are shown in Table 5. It could be stated that for the variable all min. and max standardized scores were among -3.29 and +3.29. Hence, there were no extreme z-scores in the data.

Table 5. *Minimum and maximum z scores values*

Variables	Min. z scores values	Max. z scores values
BI	-3,09	+2,86
EI	-2,43	+2,99
SC	-2,97	+,272
SO	-2,44	+2,94
RT	-2,64	+2,57
MM	-2,37	+2,44
EM	-1,55	+2,97
TM	-2,59	+2,47
SM	-2,92	+2,92

Another important assumption was determined to found multivariate outliers on the dependent variables. "Mahalanobis distance measures the distance of a particular case from the centroid of the remaining cases, where the centroid is the point created by means of all the variables" (Tabachnick & Fidell, 2007, p. 74). Mahalanobis distance for multivariate outliers in the data was calculated by using the regression section in the SPSS. Also, this value must be compared to a critical value to see the number of multivariate outliers. The critical value could be assessed for each case by the chi-square table with dependent variable numbers as being the freedom degree (df), and the value of alpha is .001 (Pallant, 2005, p. 280). On the basis of the chi-square table, nine dependent variables' column showed that the critical value was a maximum value of 15,507 for this study (Warner, 2012, p.1063).

Table 6. *Residuals statistics*

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	1,86	3,33	2,61	,264	285
Std. Predicted Value	-2,833	2,706	,000	1,000	285
Standard Error of Predicted Value	,087	,265	,202	,039	285
Adjusted Predicted Value	1,73	3,34	2,61	,267	285
Residual	-2,061	2,138	,000	1,081	285
Std. Residual	-1,876	1,946	,000	,984	285
Stud. Residual	-1,898	2,004	,000	1,002	285
Deleted Residual	-2,110	2,269	,000	1,120	285
Stud. Deleted Residual	-1,907	2,015	,000	1,003	285
Mahal. Distance	**,785**	**15,468**	**8,968**	**3,537**	**285**
Cook's Distance	,000	,025	,004	,004	285
Centered Leverage Value	,003	,054	,032	,012	285

a. Dependent Variable: Departments

The Mahalanobis distance maximum value for this study should be at most 15,507 for a nine-variable MANOVA analysis. In the obtained SPSS analysis, Mahal. A distance value of 15,468, as can be seen in Table 6, was obtained. Thus, this assumption was met for the MANOVA analysis.

Linearity

This assumption states that a linear relationship between each pair of dependent variables should exist. When the graph given below in Figure 1 was examined, there was a linear relationship between the variables since it generally started from the bottom left and went to the top right or from the top left and went to the bottom right. Thus, this assumption was also provided.

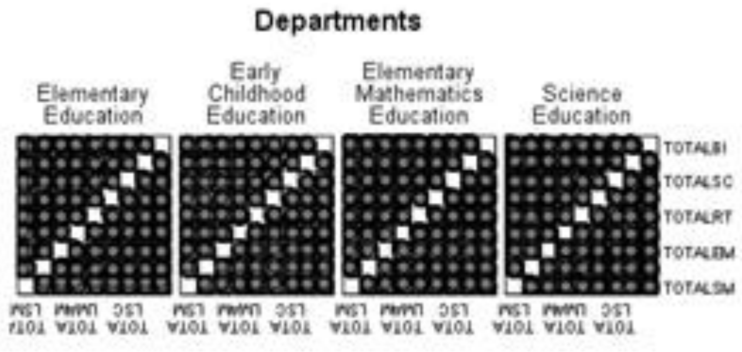

Figure 1. *Scatter plots showing linearity for the dependent variables regarding departments*

Multicollinearity

The multicollinearity is to be discussed when the input variables have a high correlation bigger than .90 (Tabachnick & Fidell, 2007). So, when this assumption was analyzed, as shown in Table 7., among the dependent variables there was no high correlation since all the correlations were lower than .90. Then, it was determined that the assumption was sufficient.

Table 7. *Pearson Correlation among the dependent variables*

		SM	TM	EM	MM	RT	SO	SC	EI	BI
SM	Pearson Correlation	1	,171**	,361**	,393**	,153**	,228**	,214**	,170**	,418**
	Sig. (2-tailed)		,003	,000	,000	,007	,000	,000	,003	,000
	N	304	304	304	304	304	304	304	304	304
TM	Pearson Correlation	,171**	1	,250**	,144*	,069	,071	,103	,134*	,032
	Sig. (2-tailed)	,003		,000	,012	,229	,220	,073	,020	,575
	N	304	304	304	304	304	304	304	304	304
EM	Pearson Correlation	,361**	,250**	1	,249**	,084	,086	,094	,060	,394**
	Sig. (2-tailed)	,000	,000		,000	,146	,135	,101	,300	,000
	N	304	304	304	304	304	304	304	304	304
MM	Pearson Correlation	,393**	,144*	,249**	1	,177**	,195**	,076	,066	,231**
	Sig. (2-tailed)	,000	,012	,000		,002	,001	,186	,251	,000
	N	304	304	304	304	304	304	304	304	304
RT	Pearson Correlation	,153**	,069	,084	,177**	1	,611**	,534**	,441**	,491**
	Sig. (2-tailed)	,007	,229	,146	,002		,000	,000	,000	,000
	N	304	304	304	304	304	304	304	304	304
SO	Pearson Correlation	,228**	,071	,086	,195**	,611**	1	,597**	,566**	,422**
	Sig. (2-tailed)	,000	,220	,135	,001	,000		,000	,000	,000
	N	304	304	304	304	304	304	304	304	304
SC	Pearson Correlation	,214**	,103	,094	,076	,534**	,597**	1	,613**	,489**
	Sig. (2-tailed)	,000	,073	,101	,186	,000	,000		,000	,000
	N	304	304	304	304	304	304	304	304	304
EI	Pearson Correlation	,170**	,134*	,060	,066	,441**	,566**	,613**	1	,407**
	Sig. (2-tailed)	,003	,020	,300	,251	,000	,000	,000		,000
	N	304	304	304	304	304	304	304	304	304
BI	Pearson Correlation	,418**	,032	,394**	,231**	,491**	,422**	,489**	,407**	1
	Sig. (2-tailed)	,000	,575	,000	,000	,000	,000	,000	,000	
	N	304	304	304	304	304	304	304	304	304

**. Correlation is significant at the .01 level (2-tailed) .
*. Correlation is significant at the .05 level (2-tailed).

Homogeneity of Variance

According to Table 8 below, because the p value as .868 is bigger than .05, the dependent variables' covariance matrices are homogeneous across the groups. Thus, this assumption was provided for the MANOVA analysis.

Table 8. *Box's test of equality of covariance matrices*

Box's M	123,952
F	,866
df1	135
df2	159692,190
Sig.	,868

For assessing homogeneity assumption for variances for MANOVA analysis could be utilized with Levene's test, so it could be controlled whether dependent variable variances' values are similar for the groups. Levene's test checks the homogeneity of group variances for each dependent variable. In Table 9 obtained in SPSS analysis, the variances of all dependent variables were found to be equal (homogeneous) (p>.05).

Table 9. *Levene's test of equality of error variances*

		Levene Statistic	df1	df2	Sig.
SM	Based on Mean (M)	,585	3	281	,625
	Based on Median (Md)	,544	3	281	,653
	Based on Median and with adjusted df (Md+df)	,544	3	270,215	,653
	Based on trimmed mean (TM)	,641	3	281	,589
TM	(M)	,810	3	281	,489
	(Md)	,662	3	281	,576
	(Md+df)	,662	3	278,385	,576
	(TM)	,799	3	281	,495

EM	(M)	,168	3	281	,918
	(Md)	,203	3	281	,894
	(Md+df)	,203	3	279,994	,894
	(TM)	,180	3	281	,910
MM	(M)	,414	3	281	,743
	(Md)	,382	3	281	,766
	(Md+df)	,382	3	279,374	,766
	(TM)	,400	3	281	,753
RT	(M)	,735	3	281	,532
	(Md)	,604	3	281	,613
	(Md+df)	,604	3	274,632	,613
	(TM)	,729	3	281	,535
SO	(M)	,451	3	281	,717
	(Md)	,475	3	281	,700
	(Md+df)	,475	3	279,758	,700
	(TM)	,480	3	281	,696
SC	(M)	,855	3	281	,465
	(Md)	,901	3	281	,441
	(Md+df)	,901	3	279,694	,441
	(TM)	,835	3	281	,476
EI	(M)	,830	3	281	,478
	(Md)	,817	3	281	,486
	(Md+df)	,817	3	275,888	,486
	(TM)	,815	3	281	,487
BI	(M)	,609	3	281	,610
	(Md)	,622	3	281	,601
	(Md+df)	,622	3	273,705	,601
	(TM)	,655	3	281	,580

Descriptive Statistics

Table 10. *Descriptive statistics for the dependent variables*

D. Variables	Departments	Mean	Std. Deviation	N
SM	ECE	19,59	2,768	63
	EE	19,69	2,259	64
	EME	19,14	2,630	79
	SE	19,65	2,592	79
	Total	19,50	2,569	285
TM	ECE	21,60	2,459	63
	EE	21,20	2,431	64
	EME	20,90	2,432	79
	SE	21,00	2,154	79
	Total	21,15	2,367	285
EM	ECE	9,68	2,983	63
	EE	9,08	2,961	64
	EME	9,30	2,738	79
	SE	9,93	2,932	79
	Total	9,51	2,901	285
MM	ECE	15,32	2,421	63
	EE	16,04	2,597	64
	EME	17,85	2,656	79
	SE	16,11	2,494	79
	Total	16,40	2,705	285
RT	ECE	26,83	2,397	63
	EE	27,41	2,629	64
	EME	26,59	2,858	79
	SE	27,59	2,703	79
	Total	27,11	2,686	285
SO	ECE	35,77	2,739	63
	EE	36,30	2,599	64
	EME	35,13	2,696	79
	SE	36,09	2,962	79
	Total	35,80	2,783	285
SC	ECE	26,99	2,569	63
	EE	27,49	2,422	64
	EME	26,03	2,824	79
	SE	26,99	2,500	79
	Total	26,84	2,634	285
EI	ECE	31,89	2,673	63
	EE	32,19	2,867	64
	EME	30,95	2,564	79
	SE	31,96	2,853	79
	Total	31,71	2,768	285
BI	ECE	24,15	3,308	63
	EE	24,67	2,912	64

EME	24,03	3,059	79
SE	24,57	2,846	79
Total	24,35	3,023	285

It was seen that there were minor differences between the mean scores of the dependent variables (SM, TM, EM, MM, RT, SO, SC, EI, BI) of the departments in Table 10 above. The significance of these differences was checked by MANOVA analysis.

Table 11. *Multivariate tests result table*

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[d]
Intercept	Pillai's Trace	,996	8170,45[b]	9,000	273,00	,000	,996	73534,05	1,000
	Wilks' Lambda	,004	8170,45[b]	9,000	273,00	,000	,996	73534,05	1,000
	Hotelling's Trace	269,35	8170,45[b]	9,000	273,00	,000	,996	73534,05	1,000
	Roy's Largest Root	269,35	8170,45[b]	9,000	273,00	,000	,996	73534,05	1,000
Departments	Pillai's Trace	,277	3,11	27,000	825,00	**,000**	,092	84,057	1,000
	Wilks' Lambda	,735	3,29	27,000	797,94	**,000**	,098	86,380	1,000
	Hotelling's Trace	,345	3,47	27,000	815,00	**,000**	,103	93,718	1,000
	Roy's Largest Root	,293	8,93[c]	9,000	275,00	**,000**	,226	80,447	1,000

a. Design: Intercept + Departments
b. Exact statistic
c. The statistic is an upper bound on F that yields a lower bound on the significance level.
d. Computed using alpha = ,05

In this current investigation, for interpreting the independent variable effect on dependent variables, Wilks' Lambda was used. When the main effect was interpreted, Wilks' Lambda analysis in Table 11 showed that the combined dependent variables significantly different across all the education departments were revealed. Thus, there were statistically significant mean differences among the groups on the combined dependent variables of SM, TM, EM, MM, RT, SO, SC, EI, and BI since Wilks' Lambda value (.735, F(27, 797,94) = 3,29, p = .000) was less than .05. Thus, the first null hypothesis was rejected. Also, the partial eta squared was a small effect size as .098 (Cohen, 1988). So, approximately 9,8% of the multivariate variance of the dependent variables was explained. Another essential statistic was that the test observed power was 1.00, and the calculated power was .80 at the beginning of the study. Thus, the differences among the groups had meaningful significance.

The second table in the MANOVA output was the "Tests of Between-Subjects Effects" to investigate further concerning each dependent variable (Table 12). If one was different, it must be found which group differed from the study findings regarding the mean scores (SM, TM, EM, MM, RT, SO, SC, EI, and BI). Thus, it was necessary to evaluate MANOVAs with Bonferroni posthoc tests. Therefore, the test was utilized, and the pairwise comparisons were shown in Table 12.

Table 12. *Tests of between-subjects effect table*

Dependent Variable		(I) Departments	(J) Departments	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
SM	Bonferroni	ECE	EE	-,10	,457	1,000	-1,31	1,11
			EME	,45	,435	1,000	-,71	1,60
			SE	-,06	,435	1,000	-1,22	1,09
		EE	ECE	,10	,457	1,000	-1,11	1,31
			EME	,55	,433	1,000	-,60	1,70
			SE	,04	,433	1,000	-1,11	1,19
		EME	ECE	-,45	,435	1,000	-1,60	,71
			EE	-,55	,433	1,000	-1,70	,60
			SE	-,51	,409	1,000	-1,60	,58
		SE	ECE	,06	,435	1,000	-1,09	1,22
			EE	-,04	,433	1,000	-1,19	1,11
			EME	,51	,409	1,000	-,58	1,60
TM	Bonferroni	ECE	EE	,40	,420	1,000	-,71	1,52
			EME	,71	,399	,469	-,36	1,77
			SE	,61	,399	,783	-,46	1,67
		EE	ECE	-,40	,420	1,000	-1,52	,71
			EME	,30	,398	1,000	-,75	1,36
			SE	,20	,398	1,000	-,85	1,26
		EME	ECE	-,71	,399	,469	-1,77	,36
			EE	-,30	,398	1,000	-1,36	,75
			SE	-,10	,376	1,000	-1,10	,90
		SE	ECE	-,61	,399	,783	-1,67	,46
			EE	-,20	,398	1,000	-1,26	,85
			EME	,10	,376	1,000	-,90	1,10

EM	Bonferroni	ECE	EE	,60	,514	1,000	-,77	1,97
			EME	,37	,489	1,000	-,93	1,67
			SE	-,25	,489	1,000	-1,56	1,05
		EE	ECE	-,60	,514	1,000	-1,97	,77
			EME	-,23	,487	1,000	-1,52	1,07
			SE	-,86	,487	,482	-2,15	,44
		EME	ECE	-,37	,489	1,000	-1,67	,93
			EE	,23	,487	1,000	-1,07	1,52
			SE	-,63	,461	1,000	-1,85	,60
		SE	ECE	,25	,489	1,000	-1,05	1,56
			EE	,86	,487	,482	-,44	2,15
			EME	,63	,461	1,000	-,60	1,85
MM	Bonferroni	ECE	EE	-,71	,452	,693	-1,92	,49
			EME	-2,53*	,430	**,000**	-3,67	-1,38
			SE	-,78	,430	,421	-1,93	,36
		EE	ECE	,71	,452	,693	-,49	1,92
			EME	-1,81*	,428	**,000**	-2,95	-,67
			SE	-,07	,428	1,000	-1,21	1,07
		EME	ECE	2,53*	,430	**,000**	1,38	3,67
			EE	1,81*	,428	**,000**	,67	2,95
			SE	1,74*	,405	**,000**	,67	2,82
		SE	ECE	,78	,430	,421	-,36	1,93
			EE	,07	,428	1,000	-1,07	1,21
			EME	-1,74*	,405	**,000**	-2,82	-,67
RT	Bonferroni	ECE	EE	-,58	,473	1,000	-1,84	,68
			EME	,23	,450	1,000	-,96	1,43
			SE	-,77	,450	,543	-1,96	,43
		EE	ECE	,58	,473	1,000	-,68	1,84
			EME	,81	,449	,423	-,38	2,01
			SE	-,18	,449	1,000	-1,38	1,01
		EME	ECE	-,23	,450	1,000	-1,43	,96
			EE	-,81	,449	,423	-2,01	,38
			SE	-1,00	,424	,116	-2,13	,13
		SE	ECE	,77	,450	,543	-,43	1,96
			EE	,18	,449	1,000	-1,01	1,38
			EME	1,00	,424	,116	-,13	2,13
SO	Bonferroni	ECE	EE	-,53	,490	1,000	-1,83	,77
			EME	,64	,466	1,000	-,60	1,88
			SE	-,32	,466	1,000	-1,56	,92
		EE	ECE	,53	,490	1,000	-,77	1,83
			EME	1,17	,464	,074	-,06	2,40
			SE	,21	,464	1,000	-1,03	1,44
		EME	ECE	-,64	,466	1,000	-1,88	,60
			EE	-1,17	,464	,074	-2,40	,06
			SE	-,96	,439	,175	-2,13	,20
		SE	ECE	,32	,466	1,000	-,92	1,56
			EE	-,21	,464	1,000	-1,44	1,03
			EME	,96	,439	,175	-,20	2,13
SC	Bonferroni	ECE	EE	-,50	,460	1,000	-1,72	,73
			EME	,97	,438	,166	-,19	2,13
			SE	,00	,438	1,000	-1,16	1,17
		EE	ECE	,50	,460	1,000	-,73	1,72
			EME	1,47*	,436	**,005**	,31	2,62
			SE	,50	,436	1,000	-,66	1,66
		EME	ECE	-,97	,438	,166	-2,13	,19
			EE	-1,47*	,436	**,005**	-2,62	-,31
			SE	-,96	,412	,121	-2,06	,13
		SE	ECE	,00	,438	1,000	-1,17	1,16
			EE	-,50	,436	1,000	-1,66	,66
			EME	,96	,412	,121	-,13	2,06
EI	Bonferroni	ECE	EE	-,29	,486	1,000	-1,59	1,00
			EME	,95	,463	,250	-,28	2,18
			SE	-,06	,463	1,000	-1,29	1,17
		EE	ECE	,29	,486	1,000	-1,00	1,59
			EME	1,24*	,461	**,045**	,02	2,46
			SE	,23	,461	1,000	-,99	1,46
		EME	ECE	-,95	,463	,250	-2,18	,28
			EE	-1,24*	,461	**,045**	-2,46	-,02
			SE	-1,01	,436	,128	-2,17	,15
		SE	ECE	,06	,463	1,000	-1,17	1,29
			EE	-,23	,461	1,000	-1,46	,99
			EME	1,01	,436	,128	-,15	2,17
BI	Bonferroni	ECE	EE	-,52	,537	1,000	-1,95	,91
			EME	,12	,511	1,000	-1,24	1,48
			SE	-,42	,511	1,000	-1,77	,94
		EE	ECE	,52	,537	1,000	-,91	1,95
			EME	,64	,509	1,000	-,71	1,99
			SE	,10	,509	1,000	-1,25	1,46
		EME	ECE	-,12	,511	1,000	-1,48	1,24

	EE	-,64	,509	1,000	-1,99	,71
	SE	-,54	,482	1,000	-1,82	,74
SE	ECE	,42	,511	1,000	-,94	1,77
	EE	-,10	,509	1,000	-1,46	1,25
	EME	,54	,482	1,000	-,74	1,82

Based on observed means.
The error term is Mean Square(Error) = 9,160.
*. The mean difference is significant at the ,05 level.

Table 12 indicated that there were statistically significant differences both between early childhood education and elementary mathematics education (p<.05) and elementary education and elementary mathematics education (p<.05) about the mean scores of students' MM. Also, there was a statistically significant difference between science and elementary mathematics education (p<.05) regarding the mean scores of students' MM. The mean differences between early childhood education and elementary mathematics education were 2,53 in favour of elementary mathematics education. It was also seen that elementary mathematics education's mean score was again higher than elementary education's (1,81). Moreover, the mean differences between science and elementary mathematics education were 1,74 in favour of elementary mathematics education.

Table 12 showed a statistically significant difference between elementary education and elementary mathematics education (p<.05) regarding the mean scores of students' SC. The mean differences between elementary education and elementary mathematics education were 1,47 in favour of elementary education.

Table 12 showed a statistically significant difference between elementary education and elementary mathematics education (p<.05) regarding the mean scores of students' EI. The mean differences between elementary education and elementary mathematics education were 1,24 in favour of elementary education.

Finally, the analysis results found no statistical difference between the mean values, other dependent variables and departments. Finally, according to the findings of the analysis, no statistical difference was found among the mean values, other dependent variables and departments.

DISCUSSION, CONCLUSION, RECOMMENDATIONS

In the current research, STEM motivation and the entrepreneurship skills of pre-service teachers educating in different departments were determined by utilizing two different scales simultaneously, as “Entrepreneurship Scale for Teacher Candidates”, and “STEM Motivation Scale” and by analysing the gathered data. Based on the findings of the research, it was found that statistically significant differences between early childhood education and elementary mathematics education, between elementary education and elementary mathematics education, and also between science and elementary mathematics education in favour of elementary mathematics education regarding the mean scores of students’ mathematical motivation (MM) in the significance level of .05. In other words, elementary mathematics education department’s pre-service teachers’ mathematical motivation scores in STEM Motivation Scale were higher than the other teacher education departments’ pre-service teachers’ mathematical motivation scores. The high mathematical motivation scores could be explained by pre-service mathematics teachers’ high university entrance exam mathematics scores and also by the lessons related to pure mathematics the pre-service mathamathics teachers have studied on through the teacher education program. According to the research results, it was important that the pre-service mathematics teachers’ high mathematical motivation for their further classes to plan, monitor and evaluate alternative mathematics teaching espeacillay in means of STEM and entrepreneurship education. Also, in literature ıt was seen that the mathematics teachers’ mathematical motivation, in means of self-efficiacy, the value they attribute in mathematics, and their emotional commitment to their profession was so important to interpret the strategies they use to plan, monitor and evaluate mathematics instruction and also the strategies they use to activate and enhance students' self-regulated learning in mathematics (Chatzistamatiou et al., 2014). The mathematics teachers’ mathematical motivation was also highlighted important in literature for their technology use in their calsses through mathematics teaching (Reinhold et al., 2021).

It was also found that there was a significant difference between elementary education and elementary mathematics education in favour of elementary education regarding the mean scores of students' self-confidence (SC) in the significance level of .05 in the Entrepreneurship Scale for Teacher Candidates. This result may be due to multidisciplinary pre-service elementary teacher education program courses. Just like the current research's results in literature, Kaasila et al. (2004) studied with 269 pre-service elementary teachers for determining their self-confidence and they found four fifth of their participants had high self confidence. Gunning and Mensah (2011) also searched the pre-service elementary school teachers' self efficiacy and self-confidence since tey believed first of all it was an important factor for student own lerning. Also, they made suggestions for further elementary teacher education programs. In the current research, it was also thought high self confidence scores of pre-service elementary school teachers would probably have a positive effect in their further classes in means of planning, organizing, monitoring, and evaluating effective teaching domains. It would be benefical to state that the research's positive self confidence results in favour of pre-service elementary teachers could make a positive contribution for academicians educating these pre-service teachers being aware of this self confidence level would positively affect their future classes, so the academicians alternative teaching-learning experiences for the pre-service teachers would contribute to this self confidence too. It could also be benefical to state that the other pre-service teacher educating departments'educators would construct verified teaching and learning domains experiences for their candidate teachers to make their self confidence high for their future classes.

Also, it was found that there was a significant difference between elementary education and elementary mathematics education in favour of elementary education regarding the mean scores of students' emotional intelligence (EI) in the significance level of .05 on the Entrepreneurship Scale for Teacher Candidates. This could be because the pre-service elementary teachers had been working with little children but with an extensive age scale being different from early childhood education, elementary mathematics education, and science education through their internships at schools as well as this could be because of the elementary teacher education program's culture came into existence through years. Being different form the current research, in literature Kaufhold and Johnson (2005) analyzed elementary school teachers' emotional intelligence levels and found not so highly results. Since it was so important to highlight that the pre-service elementary teachers' emotional intelligence level was so important for their further students to understand tham emotionally, the positive results of the current research would make a positive contribution to literature.

In the current research, there was no significance different was found beetween two grouped combinations of the different departments as early childhood education, elementary education, elementary mathematics education, and science education in means of risk taking, seeing opportunities, being innovative, sicence motivation, technology motivation, and engineering motivation sub-dimensions since the significance level was bigger than .05 for different two grouped combinations of different pre-service teacher education program. On the basis of the current research results it could be offered much more entrepreneurship skill enhanching programs and STEM educating programs in pre-service teacher education departments. In literature as offered Arruti and Panos-Castro (2020) made an international entrepreneurship education program for pre-service teachers as a longitudinal study.

In summary in literature, there were so many searching the effectiveness of alternative teaching domains on students' STEM motivation and entrepreneurship skills of students (Dönmez et al., 2022; Oosterbeek et al., 2010; Restivo et al., 2014; Starr et al., 2019; Starr et al., 2020), but being different from the literature, in the current research it was aimed to highlight pre-service teachers' STEM motivation and entrepreneurship skills together whom would be further responsible for constructing teaching domains for improving the same skills for their students. Thus, for further studies, different sub-dimensions of these skills could be studied on pre-service teachers to allow academicians to construct alternative teaching domains to improve the pre-service teachers' STEM motivation and entrepreneurship skills together.

The research was conducted on only at one state university in Turkey so this was stated as one of the limitations of the current research. Another limitation of the research was the studied programs. Only early childhood education, elementary education, elementary mathematics education, and science education departmants found place in the current research since chemistry education, physics education, biology education, mathemathics education, special education departmants' students were not availavle at the studied university. The third and the last limitation of the research was stated as the utilized scales were limited by only "Entrepreneurship Scale for Teacher Candidates", and "STEM Motivation Scale". For further researches, more than one university, high school pre-service teacher educating programs, and different scales could be employed for further contribution to literature.

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