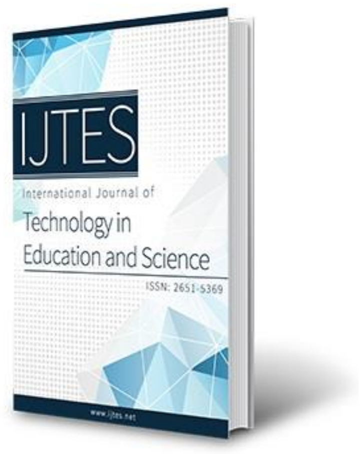


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# The Innovation Skill Levels and STEM Career Interests of 8th Grade Students

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# The Innovation Skill Levels and STEM Career Interests of 8th Grade Students

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**Abstract**

This study was conducted to investigate whether the STEM career interests and innovation skill levels of 8th grade students differ significantly according to some demographic variables. The research was the correlational model. The data of the study were collected from a total of 1427 students from 20 different schools in five randomly selected districts of Mardin province located in the southeast of Turkiye. Innovation Skill Scale, Personal Information Form and STEM Career Interest Scale were used to collect data. As a result of the analyzes, both the innovation skill levels and STEM career interests of the students showed a significant difference in favor of those with fewer siblings. In addition, the innovation skill levels and STEM career interests of the students whose mothers did not go to school were lower. STEM career interest and innovation skill levels were in favor of students whose fathers are university graduates. In addition, the increase in the family income of the student was effective in increasing the innovation skill levels and STEM career interests. Activities and projects can be organized in schools to develop students' innovation skills and STEM career interests.

## Introduction

The development of scientific knowledge and technological products has been an important place in the economic, military and commercial competition for many countries. For this reason, each country has reformed its education and learning programs to keep up with this development and to includes new methods and techniques in the programs. In this context, one of the approaches that has an important place today is STEM. When STEM is mentioned, 21st century skills immediately come to mind. 21st century skills encompass many skills. Some of these skills are skills such as creativity, innovation, innovation, entrepreneurship. The question of how we can acquisition these skills to students is being tried to be solved with the changes made in the education and learning programs (Wilson et al., 2022). In the 2016 STEM Education Report of the Ministry of National Education, the importance of innovative inventions in which STEM (science-technology-engineering-mathematics) components are integrated, that they are present in curricula in our country and in many countries around the world, and that knowledge turns into a product in education is emphasized (Doganca Kucuk et al., 2021).

Amabile stated in 1997 that the world was constantly changing and that innovation was essential for long-term corporate success. The innovation emphasized activities would enable students' innovative thinking skills in the implementation conditions of the MoNE 2018 Science Education Curriculum. Despite the importance of STEM and innovation today, many pre-service teachers could not fully explain innovation (Keleşoğlu & Kalaycı, 2017), and also institutions providing education in the field of STEM education did not have sufficient preparation and practice (Çolakoğlu & Günay Gökben, 2017). In addition, STEM was not fully understood or misunderstood in our country. The necessity of studies to increase the interest in STEM in the career field, and the acquisition of 21st century skills in education were immediate concerns in the field of STEM career interest and innovation skills in education (Rossi de Campos, 2015; Çepni, 2018; NRC, 2011)

## Innovation

Innovation was derived from the Latin word " innovatus ". It was also expressed as innovation (TDK, 2019). Drucker (2014), on the other hand, stated that innovation and novelty were separate concepts that should not be used interchangeably. Because innovation was not the result of novelty, but the result (Elçi & Karataylı, 2008). In addition, the concepts of creativity and innovation could be confused with each other, but creativity was not a concept that meets innovation (Keleşoğlu & Kalaycı, 2017). Creativity was rather the beginning of innovation (Amabile, 1997). Apart from innovation and creativity, some other concepts with close meanings related to innovation were entrepreneurship, change, invention, research and development and technology (Yaman, 2018). Innovation was defined as the implementation of practices and regulations within a business with an improved service, product, process, new marketing tactics or a new organizational method in the Oslo guide prepared by OECD in 2006 and European Commission in 2005. Since innovation included integrated meanings, it could be divided into many subclasses and diversified (Camelo et al., 1999). For this reason, it would be more appropriate to use innovation as a technical word, since there was no concept that exactly fills the meaning of innovation (Altun, 2008).

Innovation can be an idea or a product or process. It is extraordinary and original, always carrying the perception of innovation. Since innovation was a process, it was a problem-solving skill that requires continuity and was one of the most important competitive tools of our time (Uzkurt, 2008). Creative thinking was of great importance in the innovation process. The innovative idea or product went through the innovation process. For this reason, innovation was a necessary and continuous activity for all institutions (Elçi, 2006).

### Innovation in Education and Its Importance

Since the term meaning of innovation was considered as an economic concept, the concept of novelty has been used more in education. However, innovative initiatives in education were more than novelty. In addition to the curriculum development studies in education, the development of new methods and techniques were used in the teaching process (Alan, 2019). The innovative processes included in-service training of teachers and the physical changes of the school to make it suitable for education (Keleşoğlu & Kalaycı, 2017). In the literature, studies were being carried out to improve schools from their current situation. The studies aimed to increase the knowledge and skills of educators, participation of everyone in the school in the decision process, improving cooperation, prioritizing the student's learning goals, taking risks while making creative and innovative decisions; innovative reflections in education (Arıkan & Karaata, 2009, Koyuncuoglu, 2021).

The innovation was necessary to make systemic changes in education policies and to start initiatives at an early age to adapt to change in the world (Elçi, 2006). The aim of innovation was to increase the quality of education. Thus, individuals were always aware of current developments and adapted to changing technology. This change influenced on the role of education and teacher. Teachers could respond to the changing needs of the age, produce creative ideas, have strong communication skills and teamwork, recognize and use the changing technology, produce creative ideas, are self-confident, can use the technology of the age, and bring individuals with the same skills to the society (Musluoğlu, 2008). However, in the studies conducted in our country, the innovation skill levels of our students were not sufficient. Therefore, it was important to develop innovation in education (Romer, 2007; cited in Kılıçer, 2011). In today's economy, the economic welfare of a country would be determined by the country's innovation efforts. For this reason, countries could care about innovation in their education systems to exist in international competition (Lubienski, 2009).

## STEM Education and STEM Career Interest

STEM could be defined as the integration of science, technology, engineering and mathematics into education with interdisciplinary relations (Dugger, 2010). STEM entered the literature for the first time when Williams made an abbreviation as SME&T in 1995, but was changed to "STEM" by the National Science Foundation (NSF). Although its name was mentioned in the literature in the 1990s, the popularity of STEM in the field of education started in the 21st century (Ostler, 2012). The changes brought by globalization in the economic and social structure of the 21st century have also created changes in the world of business, science and technology (Soylu & Öztürk Göl, 2010). 21st century skills and sub-skills were compatible with STEM education outcomes. Therefore, students of could engage in science, technology, engineering and mathematics courses as parts of a whole (MoNE, 2016).

STEM education aimed to create products with innovative inventions and aimed to raise STEM literate individuals (MoNE, 2016). STEM literate individuals had grasped the disciplines and integrated structure of STEM and were willing to make a career in this field (Bybee, 2013). Teachers had the greatest responsibility in raising STEM literate individuals. Therefore, teachers needed to be STEM literate individuals and be aware of the importance of STEM education (Kennedy & Odell, 2014).In the report "Science Education Now: Renewed Pedagogy for Europe's Future" published by the European Union in 2007, today's youth have lost interest in STEM-containing courses and were not willing to pursue a career in this field. In the same report, students' career interests in STEM fields should be increased for a sustainable society. STEM education had great importance in the development of a nation (European Commission, 2007). Career was the success that individuals want to achieve throughout their life and the level of expertise in the business field (Yüksel, 2000). The US National Research Council highlighted the importance of increasing the number of people pursuing a career in STEM in the goals of STEM education. Therefore, it was as important as STEM education that individuals who have undergone this education have a positive attitude towards careers in STEM fields (NRC, 2011). Therefore, one of the outputs of STEM education was to increase the number of individuals willing to make a career in STEM fields (Ostler, 2012).

STEM processes included innovation in order for the studies in the STEM field to reach their goal (Carnevale & Smith, 2013). When the programs of the countries that teach based on STEM education were examined, it was seen that they are also the leading countries in innovation. Because STEM disciplines supported the main goals of innovation. For this reason, innovation and STEM were concepts that support each other and that the increase in the number of individuals who make careers in this field would make great contributions to economic development. (Turkish Industrialists' and Businessmen's Association [TUSIAD], 2017). Therefore, STEM and innovation were related to each other and were important in both education and economic development goals. Researches showed that students' career interests begin to take shape in primary education (Auger et al., 2005). Many students lost their interest of science in the following years (Lederman, 2008). For this reason, the 10-14 age range was an important period for students who were successful in STEM fields to participate in STEM activities and gained career interest in this field (Maltese & Tai, 2011). Thus, in this study, it was examined whether the STEM career interests and innovation skill levels of secondary school 8th grade students made a significant difference according to some sociodemographic characteristics.

Sub-problems of the present study;

1. Do the innovation skill levels and STEM career interests of 8th grade secondary school students differ significantly according to the number of siblings of the individuals?
2. Do the innovation skill levels and STEM career interests of 8th grade secondary school students differ significantly according to the education level of their parents?
3. Do the innovation skill levels and STEM career interests of 8th grade secondary school students differ significantly according to family income?

## Method

### Research Pattern

Survey research model was used to describe a situation and reveal an existing situation. This study was a survey research model as it was conducted to reveal an existing situation. The model of the research was the correlational survey model, as it tried to reveal the existence or degree of co-change of two or more variables (Karasar, 2012).

### Universe-Sample

The universe of the research was 8th grade students in secondary schools in Mardin, a border province with Syria located in the southeastern Anatolia region of Turkiye. Data were not collected from all grade levels since the innovation skill levels of the students may differ according to the education level. In addition, it was preferred to work with 8th grade students who will choose secondary education because it is foreseen that students' career interests may change over time. The city of Mardin was chosen as the universe of the research in terms of providing data diversity for the research, such as the multi-sibling family structures, the diversity in the education levels of the parents, and the different socioeconomic levels of the family income distributions, as well as the diversity of beliefs and cultures of Mardin. In order to obtain this data diversity, purposive sampling was chosen from non-random sampling methods (Büyüköztürk, et al., 2017). The sample of the research consisted of a total of 1427 students from twenty schools selected from five districts of Mardin.

### Data Collection Tools

The measurement tools of this study; "Personal Information Form", "Innovation Skill Scale" and "STEM Career Interest Scale" were used. In the personal information form used, the student's gender, family monthly income, number of siblings, education level of parents, etc. sociodemographic characteristics. “Innovation skill scale for youth” developed by Chell and Athayde in 2009 was translated into Turkish by Akkaya in 2016 and a language validity study was conducted. The scale contains 31 items answered on a five-point Likert scale to measure the innovation skill levels of the participants. This scale measured the skills required for innovation. These skills (sub-dimensions) are given below:

Creativity (imagination, connecting thoughts, addressing and solving problems, curiosity); Self-efficacy (self-belief, self-confidence, self-knowledge, feeling that you can do something, social confidence); Energy (drive, enthusiasm, drive, hard work, perseverance and dedication); Risk propensity (a combination of risk tolerance and ability to take calculated risks); Leadership (ability to mobilize vision and commitment). Sample items for sub-dimensions were “I would like my lessons to involve lots of different creative activities.” for creativity, “I really like being leader of a group.” for leadership, “I feel really enthusiastic about my chosen subjects” for energy, “I’ve been brought up to think for myself.” for self-efficacy, “I want my work to provide me with opportunities to show that I can overcome problems.” for risk-propensity. For this study, it was applied to 229 8th grade students, and as a result of the analyzes, the Cronbach alpha reliability value was found to be .86 for the scale. The “STEM career interest scale” was developed by Kier, Blanchard, Osborne and Albert (2014) and translated into Turkish by Koyunlu Unlu, Dokme and Unlu (2016). It was a 44-item scale answered on a five-point Likert scale used to measure students' attitudes and career interests towards STEM fields. Sample items for sub-dimensions were “I plan to use science in my future career.” for science, “I like my mathematics class.” for mathematics, “I am able to learn new technologies.” for technology, “I like activities that involve engineering” for engineering. As a result of the application to 228 secondary school 8th grade students, the scale was used by subtracting the four items whose item-total correlation values were below .30. General Cronbach alpha coefficient for this scale was found as .93.

### Data Analysis

The data collected with Personal Information Form, Innovation Skill Scale and STEM Career Interest Scale were transferred to the computer environment and analyzed with the SPSS 21.0 program. The scores of participants were normally distributed according to the skewness and kurtosis coefficients of the scores (Yap & Sim, 2011). One-way ANOVA was used in the analysis of the sub-problems, which examined whether students' innovation skill levels and STEM career interests showed significant differences according to the student's number of siblings, parents' educational status, and family income (since the sample consisted of more than two independent groups) (Köse & Öztemur, 2014).

## Results

### Findings of the First Research Problem

The total scores of secondary school students on the scales of innovation skill levels and STEM career interests showed a normal distribution according to the number of siblings. The skewness and kurtosis coefficients of the students' scores in the innovation skill levels were skewness: -.086, kurtosis: -.494 according to number of siblings 1-3; skewness: -.249, kurtosis: -.265 according to number of siblings 4-5; skewness: .032, kurtosis: -.643 according to number of siblings 6-7; skewness: -.107, kurtosis: -.591 according to number of siblings 8-over. The skewness and kurtosis coefficients of the students' scores in the STEM career interests were skewness: -.262, kurtosis: -.526 according to number of siblings 1-3; skewness: -.192, kurtosis: -.638 according to number of siblings 4-5; skewness: -.318, kurtosis: -.337 according to number of siblings 6-7; skewness: -.222, kurtosis: -.440 according to number of siblings 8-over.

The innovation skill levels of the students showed a significant difference according to the number of siblings [$F_{(3-1423)} = 5.284$, $p<.01$]. The ANOVA test was conducted to determine between which groups this difference is. Considering the results of the ANOVA test, it showed a significant difference in favor of students who have between 1 and 3 siblings (see Table 1 and 2).

Table 1. Descriptive Statistics of the Number of Siblings Variable

| Number of siblings | 1-3 | | | 4-5 | | | 6-7 | | | 8-over | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | Mean | sd | N | Mean | sd | N | Mean | sd | N | Mean | sd |
| Innovation | 449 | 127.44 | 13.80 | 568 | 124.55 | 14.02 | 277 | 124.82 | 14.81 | 133 | 122.78 | 16.76 |
| STEM | 449 | 153.61 | 24.65 | 568 | 149.06 | 25.16 | 277 | 149.35 | 24.19 | 133 | 148.11 | 23.90 |

There was a significant difference in STEM career interests according to the number of siblings [$F_{(3-1423)} = 3.635$, $p<.05$]. The ANOVA test was carried out to determine between which groups this difference is. There was a significant difference in favor of students who have 1-3 siblings (see Table 2).

Table 2. ANOVA Test Results Regarding the Number of Siblings Variable

| | | Sum of squares | df | Mean Squares | F | p |
|---|---|---|---|---|---|---|
| Innovation | Between groups | 3278.696 | 3 | 1092.899 | 5.284 | .001* |
| | Within groups | 294340.291 | 1423 | 206.845 | | |
| | Total | 297618.987 | 1426 | | | |
| STEM | Between groups | 6651.861 | 3 | 2217.287 | 3.635 | .012* |
| | Within groups | 868124.572 | 1423 | 610.066 | | |
| | Total | 874776.433 | 1426 | | | |

**Findings of the Second Research Problem**

The total scores of secondary school students from the innovation skill levels and STEM career interest scales showed a normal distribution according to the education level of their parents. The skewness and kurtosis coefficients of the students' scores in the innovation skill levels according to mother education level were skewness: .077, kurtosis: -.492 for illiterate; skewness: -.089, kurtosis: -.652 for primary school; skewness: -.308, kurtosis: -.328 for secondary school; skewness: .003, kurtosis: -.337 for high school; skewness: -.106, kurtosis: -.046 for university; skewness: .052, kurtosis: -.289 for graduate. The skewness and kurtosis coefficients of the students' scores in the STEM career interests according to mother education level were skewness: -.209, kurtosis: -.683 for illiterate; skewness: .005, kurtosis: -.770 for primary school; skewness: -.295, kurtosis: -.624 for secondary school; skewness: -.124, kurtosis: -.389 for high school; skewness: -.416, kurtosis: -.374 for university; skewness: .220, kurtosis: -.955 for graduate.

Table 3. Descriptive Statistics of the Mother Education Level Variable

| | | Innovation | STEM Career Interest |
|---|---|---|---|
| Illiterate | N | 364 | 364 |
| | Mean | 122.54 | 146.70 |
| | sd | 13.95 | 25.27 |
| Primary School | N | 443 | 443 |
| | Mean | 124.86 | 148.84 |
| | sd | 15.37 | 25.91 |
| Secondary school | N | 337 | 337 |
| | Mean | 127.03 | 153.14 |
| | sd | 14.34 | 24.21 |
| High school | N | 205 | 205 |
| | Mean | 127.74 | 154.72 |
| | sd | 12.75 | 21.70 |
| University | N | 59 | 59 |
| | Mean | 128.88 | 154.85 |
| | sd | 13.57 | 23.43 |
| Graduate | N | 19 | 19 |
| | Mean | 123.79 | 153.21 |
| | sd | 14.44 | 20.73 |
| Total | N | 1427 | 1427 |
| | Mean | 125.35 | 150.46 |
| | sd | 14.45 | 24.77 |

In the analysis results, there was a significant difference between the innovation skill levels of the students according to the mother education level of the [$F_{(5\text{-}1421)}=5.722$, $p<.01$]. There was a significant difference between the students whose mothers were illiterate and those whose mothers were secondary school graduates in favor of the students whose mothers were secondary school graduates. Also, there was a significant difference between the students whose mothers were illiterate and those whose mothers were high school graduates in favor of the students whose mothers were high school graduates (see Table 3 and 4).

Table 4. ANOVA Test Results Regarding the Mother Education Level Variable

| | | Sum of squares | df | Mean Squares | F | p |
|---|---|---|---|---|---|---|
| Innovation | Between groups | 5874.142 | 5 | 1174.828 | 5.722 | .000* |
| | Within groups | 291744.845 | 1421 | 205.310 | | |
| | Total | 297618.987 | 1426 | | | |
| STEM | Between groups | 13716.356 | 5 | 2743.271 | 4.527 | .000* |
| | Within groups | 861060.077 | 1421 | 605.954 | | |
| | Total | 874776.433 | 1426 | | | |

Students' STEM career interests scores also differed significantly according to their mother's education level [$F_{(5\text{-}1421)} = 4.527$, $p<.01$]. There was a significant difference between the students whose mothers were illiterate and those whose mothers were secondary school graduates in favor of the students whose mothers were secondary school graduates. There is a significant difference between students whose mothers were illiterate and those whose mothers were graduated from high school, in favor of students whose mothers were high school graduates.

The skewness and kurtosis coefficients of the students' scores in the innovation skill levels according to father education level were skewness: .233, kurtosis: -.161 for illiterate; skewness: .068, kurtosis: -.628 for primary school graduate; skewness: .020, kurtosis: -.503 for secondary school graduate; skewness: -.256, kurtosis: -.402 for high school graduate; skewness: -.432, kurtosis: -.027 for university graduate; skewness: -.130, kurtosis: -.756 for graduate. The skewness and kurtosis coefficients of the students' scores in the STEM career interests according to father education level were skewness: -.234, kurtosis: -.570 for illiterate; skewness: .048, kurtosis: -.665 for primary school; skewness: -.232, kurtosis: -.599 for secondary school; skewness: -.330, kurtosis: -.463 for high school; skewness: -.250, kurtosis: -.673 for university; skewness: -.270, kurtosis: -.301 for graduate.

The innovation skill levels of the students differed significantly according to the education level of the father [$F_{(5\text{-}1421)} = 4.933$, $p<.01$]. According to the results of the ANOVA test, there was a significant difference between the students whose fathers were secondary school graduates and those whose fathers were university graduates, in favor of the students whose fathers were university graduates (see Table 5 and 6).

Table 5. Descriptive Statistics of Students' Father Education Level Variable

| | | Innovation | STEM Career Interest |
|---|---|---|---|
| Illiterate | N | 72 | 72 |
| | Mean | 122.82 | 144.96 |
| | sd | 14.02 | 26.12 |

| | | Innovation | STEM Career Interest |
|---|---|---|---|
| Primary School | N | 288 | 288 |
| | Mean | 123.65 | 148.01 |
| | sd | 14.83 | 24.70 |
| Secondary school | N | 423 | 423 |
| | Mean | 123.81 | 149.24 |
| | sd | 14.53 | 24.05 |
| High school | N | 368 | 368 |
| | Mean | 127.18 | 151.19 |
| | sd | 13.59 | 24.64 |
| University | N | 198 | 198 |
| | Mean | 127.97 | 156.94 |
| | sd | 13.29 | 25.02 |
| Graduate | N | 78 | 78 |
| | Mean | 126.92 | 151.31 |
| | sd | 17.58 | 24.98 |
| Total | N | 1427 | 1427 |
| | Mean | 125.35 | 150.46 |
| | sd | 14.45 | 24.77 |

Analysis results showed that students' STEM career interests differed significantly according to their father's education level [$F_{(5\text{-}1421)}$ =4.320, p<.01]. According to the results of the ANOVA test, there was a significant difference between the students whose fathers were illiterate and those whose fathers were university graduates, in favor of the students whose fathers were university graduates. Also, students whose fathers were university graduates differed significantly from students whose fathers were primary and secondary school graduates in favor of the students whose fathers were university graduates.

Table 6. ANOVA Test Results Regarding the Variable of Father Education Level of Students

| | | Sum of squares | df | Mean Squares | F | p |
|---|---|---|---|---|---|---|
| Innovation | Between groups | 5078.235 | 5 | 1015.647 | 4.933 | .000* |
| | Within groups | 292540.752 | 1421 | 205.870 | | |
| | Total | 297618.987 | 1426 | | | |
| STEM | Between groups | 13096.779 | 5 | 2619.356 | 4.320 | .001* |
| | Within groups | 861679.654 | 1421 | 606.390 | | |
| | Total | 874776.433 | 1426 | | | |

**Findings of the Third Research Problem**

The total scores of secondary school students from the scales showed a normal distribution according to family income. The skewness and kurtosis coefficients of the students' scores in the innovation skill levels according to family income variable were skewness: -.096, kurtosis: -.463 for very low; skewness: -.176, kurtosis: -.350 for low; skewness: -.071, kurtosis: -.480 for medium; skewness: -.283, kurtosis: -.557 for high. ; The skewness and kurtosis coefficients of the students' scores in the STEM career interests according to family income variable were skewness: -.135, kurtosis: -.535 for very low; skewness: -.215, kurtosis: -.740 for low; skewness: -.328, kurtosis: -.460 for medium; skewness: -.117, kurtosis: -.854 for high.

Table 7. Descriptive Statistics of Family Income Variable

| | Very low | | | Low | | | Middle | | | High | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | Mean | sd | N | Mean | sd | N | Mean | sd | N | Mean | sd |
| Innovation | 446 | 122.14 | 14.42 | 537 | 125.60 | 14.48 | 280 | 127.22 | 13.05 | 164 | 130.02 | 14.86 |
| STEM | 446 | 147.77 | 24.04 | 537 | 150.18 | 25.80 | 280 | 151.84 | 24.62 | 164 | 156.34 | 22.46 |

Analysis results showed that there was a significant difference between students' innovation skill levels according to family income [$F_{(3\text{-}1423)}$ =5.284, p<.01]. In the ANOVA test results, there was a significant difference between students with very low family income and students with low family income in favor of students with low family income; students with very low family income and students with middle family income in favor of students with middle family income. A significant difference was observed between students with high family income and students with high family income, and between students with low family income and students with high family income in favor of students with high family income (see Table 7and 8).

Table 8. ANOVA Test Results Related to Family Income Variable

| | | Sum of squares | df | Mean Squares | F | p |
|---|---|---|---|---|---|---|
| Innovation | Between groups | 9184.397 | 3 | 3061.466 | 15.104 | .001* |
| | Within groups | 288434.590 | 1423 | 202.695 | | |
| | Total | 297618.987 | 1426 | | | |
| STEM | Between groups | 9482.560 | 3 | 3160.853 | 5.198 | .000* |
| | Within groups | 865293.873 | 1423 | 608.077 | | |
| | Total | 874776.433 | 1426 | | | |

Analysis results showed that there was a significant difference between students' STEM career interests according to family income [$F_{(3\text{-}1423)}$ =5.198, p<.01]. When the results of the ANOVA test, there was a difference between students with very low family income and students with high family income in favor of students with high family income, and between students with low family income and students with high family income in favor of students with high family income.

## Discussion and Conclusion

### Students' STEM Career Interests in Terms of the Number of Siblings Variable

In the study, the significant difference in the STEM career interests of the students was in favor of the students with 1-3 siblings between the students with 1-3 and 4-5 siblings. When the literature was examined, no study was found that investigated the significant difference in the STEM career interests according to the number of siblings. This study was carried out in the province of Mardin and a sample of different sibling numbers was reached. Increase in the number of siblings in the family might cause limited resources and experiences for students due to the lack of interest towards the child, financial resources, time, richness of life. Most of the students of families with many children did not have a career plan for the future. Also, they had to work in any job that will provide financial resources to contribute to the family's livelihood in a short time. This leaded us to the conclusion that students did not even have educational career plans or even dreams due to the economic inadequacy created by the family structure with many children.

**Innovation Skills of the Students in Terms of the Number of Siblings Variable**

The innovation skill levels of the students were significantly differed in favor of students with 1-3 siblings (compared to those with 4-5 siblings or 8-oversiblings). As a result of this study, as the number of siblings increased for the province of Mardin, a decrease in the innovation skills of the students was observed. This result could be related to less effort, time and financial resources spent on the child as the number of siblings increases. In the study of Akkaya (2016), no significant difference was found students’ innovation skill levels according to students with the different number of siblings. This may be due to differences in culture and lifestyle between the two cities.

**STEM Career Interests in Terms of Student's Parent Education Level Variable**

In the research, STEM career interests of the students differed significantly according to the education level of the mother. While this difference was in favor of the students whose mothers were secondary and high school graduates according to mothers were illiterate. Also, 364 of 1427 students' mothers (approximately 25.5%) never went to school (illiterate). This situation showed the consequences of deprivation of girls' right to education and that this deprivation affects generations more than individuals. In a study conducted by Azgın in 2019, students' career interests did not have a significant relationship with their mother's occupation, but the average of students' STEM career interest increased as the education level of the mother increased. Kızılay (2018), on the other hand, noted that those whose mothers were university graduates were more interested in STEM careers.

Considering the findings, students' STEM career interests were related to their father's education level. STEM career interest of students whose fathers were university graduates was significantly higher than students whose fathers did not go to school or who were primary-secondary school graduates. While examining the relationship between father's education level and STEM career interest, Azgın (2019) stated that father's education level did not make a difference towards STEM career interest, but as the father's education level increased, the average of the scores obtained from the STEM career interest scale increased. Kızılay (2018), on the other hand, stated that the STEM career interests of students whose fathers were university graduates also showed a significant difference.

When the results of other studies were evaluated together, although all studies did not find a significant difference between parental education level and STEM career interest, all of them gave clues that STEM career interests increases as parents' education levels increases. In the study that investigated innovation barriers and incentives, students with low educational level of parents gave low scores to the option "My parents' education level is at a level that can support me" and that students saw parental education as an obstacle in terms of innovation development (Ozdemir Karaca, 2011).

**Innovation Skills of the Students in Terms of the Variable of Parent Educational Status of the Students**

The innovation skill levels of the students whose mothers did not go to school were lower than those whose mothers are secondary school graduates or high school graduates. When the innovation skill levels of the students according to their father's education level were examined, it was in favor of the students whose fathers were university graduates among those whose fathers were secondary school graduates and those whose fathers were university graduates. As the education level of people increased, they could adapt to innovation earlier (Rogers, 1995; Demirsoy, 2005). In addition, Esen (2002) concluded in a study that members of families with higher education levels were more innovative. In addition to these proponent studies, there were also studies in which we came across findings to the contrary. Considering the findings in Akkaya's (2016) study, students' innovation skills did not make a significant difference according to the education level of their parents. In the studies conducted by Kılıçer (2011) with pre-service teachers, the innovativeness scores of the pre-service teachers did not make a statistically significant difference. These results may be due to the high and similar educational level of the pre-service teachers rather than the education level of the parents.

**STEM Career Interests in Terms of Student's Family Income Variable**

In the study, STEM career interests of the students differed significantly according to the family monthly income of the student. STEM career interests of students with high family income differed significantly in favor of students with high family income compared to students with very low and low family monthly income. In the study of Kızılay (2018) with students in Kayseri, children with high family monthly income have a significantly higher STEM career interest. Zor (2006) in a similar study conducted with high school students noted that as the family monthly income of the students increased, their interest in some professions in the STEM fields increased. In the study conducted by Azgın (2019) with students in Muğla, even though there was no significant difference, the average STEM career interest scores increased as the family monthly income increased. In international studies, Dabney et al. (2012) and Bolds (2017) stated that as the socioeconomic status of students improved, their desire for a career in STEM fields also increased. Also, opponent studies concluded that low-income students were more interested in STEM fields (Lichtenberger & George Jackson, 2013).

In a conclusion, the students of families with higher incomes were more interested in STEM careers. This difference could be narrowed in our western cities, as there were more crowded and metropolitan cities, as there was an opportunity to meet and get to know more occupations. In addition, family income might also be important in terms of providing students with a richness of life and providing more opportunities to introduce the profession.

**Innovation Skills of the Students in terms of the Student's Family Income Variable**

As a result of this research, the innovation skill levels of the students differed significantly according to their family income. The innovation skill levels of the students with very low family monthly income were found to be significantly lower than the other income levels (low, medium and high). On the other hand, the innovation skill levels of students with high monthly family income were significantly different in favor of students with high income compared to students with medium monthly income. In other words, as the monthly income of the student's family increased for the province of Mardin, the innovation skill levels also increased. In Özdemir Karaca's (2011) study, which examined the barriers and incentives affecting the innovation ideas of 8th grade students, family monthly income had an effect on innovation skills. In addition, the income of citizens was also very important in the development and innovation demand of countries and also innovation skill levels were suggested a solution to reducing income inequalities (Kılınç, 2011). Moreover, individuals with high economic welfare were more innovative individuals (Rogers, 1995). Demirsoy (2005) concluded that monthly income was not effective in terms of early or late adoption of innovative practices. On the other hand, Esen (2002) concluded that individuals with high incomes adopt innovation earlier. Akkaya (2016), on the other hand, noted that there was no significant difference between his family's monthly income and innovation skill levels. Rogers (1995) stated that wealth alone could not be an indicator of innovation and innovation was highly correlated with economic income.

In a summary, financial income was effective on the development of innovative skills. This difference might increase or decrease depending on many variables such as city to city, different education levels or being in a profession. The social structure of the living environment, perspective on culture and education, easy and cheap transportation to social activities (sports, art, museums, science fairs, etc.) could reduce the barrier of financial income to innovation. This might be one of the reasons why there was no significant difference between family economic income and innovation skills in the study conducted in town center. The inadequacy or accessibility of the above-mentioned activity and development units in Mardin was a laborious task besides the cost, especially for those in rural areas. For this reason, since students' ability and opportunities to acquire the richness of life would differ according to their financial income level, their innovation skills might be affected by the family income situation.

## Recommendations

- Students can be introduced to professions that aim to make a career in STEM. Career interest in STEM fields can be increased through promotional activities. In order to eliminate the perception of gender in the professions, guidance activities can be carried out on the fact that female students can make a career in STEM fields and be successful.
- In the STEM section, which is the last unit of the secondary school level science book, career awareness can be created in this field by introducing STEM professions.
- Activities and projects can be organized in schools to develop students' innovation skills and STEM career interests.

- Education of individuals is very important for the development of society. Therefore, family planning can be expanded throughout the country. Thus, the negative impact of an unplanned family structure (with many children) on the ability to innovate and interest in STEM careers can be reduced. Considering the effect of mother's education level on both STEM career interest and innovation skill levels, more functional legal arrangements can be made to encourage girls to education.
- Since this research was conducted at the 8th grade level of primary education, similar studies can be conducted at different educational levels to examine how innovation skill levels or STEM career interests change in education levels.
- In the next research, interviews can be conducted in order to reveal the students' views in depth.

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