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STEM Career Interest of Kazakhstani Middle and High School Students

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Abstract: The aim of this study is to analyze secondary school students' career interests in STEM subjects. This survey-based quantitative research is provided to gain insight into the STEM career interests of 398 students (7–11 graders), in the Almaty region of the Kazakhstan Republic. Through parametric and non-parametric test analysis, the relationship between students' STEM career interest and their gender, their parents' occupation, parents' education, family size, school type, and school location were revealed. Results indicated that, on average, participant students showed positive interest in STEM careers. In particular, boys' and girls' responses were equally positive in many sub-scales of STEM. Additionally, great interest in STEM careers was shown by village students, whereas, for private school students who are living in the city, STEM career interests were the lowest in our sample. We also found that students' family size, parents' education, and occupation does not relate to students' STEM career interest. Implications for STEM education in Kazakhstan are further discussed in this study.

Keywords: Kazakhstan STEM education; secondary school STEM; STEM education; STEM career interest

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1. Introduction

Among the study disciplines of tertiary education, those concerning Science, Engineering, Technology and Mathematics (STEM) still represent a sore point of the education system around the world. On average, across OECD (Organization for Economic Co-operation and Development) and partner countries, 27% of new entrants into bachelor's programs enroll in a STEM field [1], but these numbers still seem to be too low to satisfy the need for qualified scientific human resources [2]. Suffice it to think, in fact, that the next few years will be crucial to addressing and solving long-standing problems, such as climate change and the consequent necessity of building alternative models of growth, which would require more and more technical and scientific skills [3].

For this reason, the scientific community, and science education research, in particular, has been committed for many years to finding ways to favor the choice of STEM careers by young people [4,5]. As a starting point of this effort, a detailed analysis of the factors that have been shown to influence this choice is needed, in order to eventually act on them.

In general, students' attitudes towards STEM disciplines seem to be generally positive [6,7]—although with some differences between nationality, gender, and subject [5,8]—but their interest in becoming a scientist is low [7,9]. Christidou, 2011, effectively summarized this paradox writing: "students rapidly lose their interest in science and cease seeing it as a viable option for their future or associating it with their success aspirations". This tendency could be due to the fact that students' knowledge about scientific professions is often limited, confused, and filled with stereotypes [10,11]. In some cases, scientists' work is exaggerated, so that scientists are only seen as intellectually gifted geniuses, who sacrifice their life to the conquest of knowledge [12,13]. In some other cases, on the contrary, their job is oversimplified. A striking example in this sense is provided by Kier, 2013, and her colleagues, who trace in the literature the development of children's imaginary about engineers: elementary students commonly draw engineers as men who fix things like a mechanic [14], and middle school students follow the same path representing engineers as males who work on cars, trains or fix and build things [14,15]. Scientific activity thus suddenly becomes, as a whole, impersonal, competitive, guided by rules, and lacking imagination, especially for girls [16,17]. Inevitably, this imaginary negatively shapes students' self-efficacy toward science [18,19] and directly affects their intentions of pursuing a STEM career in the future [20].

Students interest in STEM subjects vary according to gender [21]. Many studies support significant gender differences [22–25], while few studies found no gap or little gap [26,27].

The learning environment in which students grow also strongly influences their STEM career interest. In addition to the type of school and its location [28], the teaching approach to which students are exposed greatly affects them. Still today scientific subjects are often taught with a traditional teacher-centered mode which leads students to think that science is boring or constituted by a sterile sequence of notions [7,29,30], while a more meaningful, informal, flexible, peer-reviewed, collaborative, student-driven inquiry modality demonstrated to be enormously more effective [31,32]. Moreover, sometimes teachers are unknowingly driven by some bias that influences the way students build their own relationship with science, especially when it comes to girls [29,30,33].

STEM career propensity is also affected by society at large. Family members and their job occupation and education, peers, role models offered by the media, extracurricular experiences: all these elements combined define students' academic aspirations [34,35].

Faced with such a complex set of factors that intertwine with each other, research in science education developed and optimized tools that help to predict interest and intent to pursue tertiary education careers from young people. Even in the last 15 years alone, numerous instruments have been proposed. In 2008, Whitfield, Feller, and Wood [36] identified 10 instruments that are effective at determining career interests in their "Counselor's guide", which, even though not specifically dedicated to STEM disciplines, has been cited by subsequent more focused studies [9,37]. In 2009, Bowdich [38] developed a career interest questionnaire (CIQ) for a project promoting STEM interest in Hawaii: a Likert-type (1 = strongly disagree to 5 = strongly agree) instrument composed of 13 items on three scales. Subsequently, in 2010, Tyler-Wood and colleagues [39] re-elaborated Bowdich's CIQ obtaining a Likert-type (1 = strongly disagree to 5 = strongly agree) instrument composed of 12 items that measures students' interest in careers in broad science areas. In addition to this questionnaire, they also used the STEM semantic survey, that aims at measuring interest in science, technology, engineering, and mathematics, as well as interest in STEM careers by both students and teachers, analyzing five pairs of opposing adjectives (i.e., "fascinating" vs. "mundane").

All the tools presented so far, however, although effective, do not rely on a real theoretical framework.

Other proposals are instead based on a theoretical framework proposed in 1994 by Lent [40], called social cognitive career theory (SCCT). This model, developed from Bandura's [41] general social cognitive theory, aims at exploring three aspects of career development: how career interests develop, how educational and career choices are made, and how academic and professional success is accomplished. In order to achieve this, SCCT considers three fundamental elements: self-efficacy beliefs, outcome expectations, and goals. These elements, combined with personal inputs (i.e., race, gender, predispositions . . .), intrapersonal factors (such as personality) and interests, can explain how individuals make career-related decisions [9]. Guided by this model, many subsequent studies focused on assessing interest in STEM content areas and STEM careers. For example, Fouad [42] measured self-efficacy, outcome-expectancy and intentions and goals in mathematics; Baldwin [43] made an analogous thing for biology; Stone [44] focused on beliefs, attitudes, and intentions to pursue careers in information technology. A survey measuring interest in different subject area (science, technology, engineering, and mathematics) was instead developed by Kier and her colleagues [9], called the STEM Career Interest Survey (STEM-CIS). In this case, questions were developed based on self-efficacy, outcome expectation, personal inputs, and contextual support and barriers.

STEM in Kazakhstan

In the last decade, the active development of STEM education has also begun in Kazakhstan. According to the Department of Ministry of Education and Science of the Republic of Kazakhstan (Ministry of Education and Science of the Republic of Kazakhstan (MEARK), 2022), since the 2016–2017 academic year, the elective course "Robotics", which is aimed to develop STEM among middle and high school students, has been implemented in 2500 schools. A robotics laboratory has been opened in 1100 schools. Overall, 1626 schools (23.1%) have robotics elective courses with more than 32,000 students (Ref). To support this, activities in annual republican and international robotic Olympiads are held since 2016 all around the country, such as the Republican Olympiad in robotics, International Robotics Festival "RoboLand", etc., (Ref). The winners of the republican competitions have the opportunity to participate in the World Robotics Olympiad (WRO).

Unfortunately, until now, governmental programs about broad implementation of STEM in Kazakhstan were limited by the field of robotics [45,46]. This year, the State Program for the Development of Education and Science began to develop interdisciplinary links between STEM subjects. Implementation of the new educational policy is aimed to master students' knowledge about new technologies, scientific innovations, and mathematical modeling during physics, Math, Biology, Chemistry, and Technology subjects [47]. It shows us that Kazakhstani education needs comprehensive STEM research, which prompted us to carry out current research. To achieve the goal of our work we set the following research questions:

1. How do students' STEM Career Interest changes across grade levels for each STEM subject?
2. How do students' STEM Career Interest changes across gender for each STEM subject?
3. Is there a relationship between students' STEM Career Interest and the number of siblings for each STEM subject?
4. Is there a relationship between students' STEM Career Interest and their Physics, Maths, Chemistry, and Biology grades for each STEM subject?
5. Is there a relationship between students' STEM Career Interest and their parents' occupation and education?
6. Is there a relationship between students' STEM Career Interest and the school type and location?

2. Materials and Methods

This is a survey based on quantitative research, it was provided to gain insight about STEM career interest of 7–11 graders, in the Almaty region of Kazakhstan Republic.

2.1. Instrument

In the research, we have used STEM Career Interest Survey (STEM-CIS) that was initially developed by Kier, Blanchard, Osborne, and Albert (2014), in order to define the factors that affect students STEM Career Interest in their future life. The survey consists of 44 items and four sub scales; Science, Technology, Mathematics, and Engineering, which were based on Bandura's social cognitive theory. This social cognitive theory examines factors, such as self-efficacy, outcome expectation, personal input, contextual support, and barriers.

The reliability and psychometric properties of the STEM-CIS was established by more than 1000 students. The survey includes questions such as: I am able to get good marks in science subjects, I am able to complete my Math subjects homework, I plan to use technology in my future career, I will work hard on activities at school that involve engineering, etc.

We used this survey to find out how students' attitude to STEM career interest changes according to grade level, gender, end of term marks from STEM subjects (Math, Physics, Biology, and Chemistry), students' parents education and job occupation, number of siblings in the family, location, and type of school attended.

We found that Cronbach's alphas for the 44 items of Career Interest Survey were 95. Moreover, the item total correlation values were between 0.29 and 0.65, and if any items were deleted from the survey, Cronbach's alphas either did not change or decreased. Thus, all items were kept for further analysis.

2.2. The Sample Specification

Current research was carried out in Almaty. Almaty is the biggest city in Kazakhstan with a population of more than 1.777 million people. As in many other big cities, Almaty has many schools that have different programs and styles of teaching. Along with Almaty city, we collected responses from students who live in nearby city regions (suburbs) and students who live in the villages which are far away from Almaty city.

In our sample, we had five different types of schools: Governmental school (GS), specialized school for gifted children (GC), Private school (PS), Gymnasium (G), and Intellectual school (IS). These five types of schools mainly aimed to cover the governmental educational program, which was established by the Ministry of Education of Republic of Kazakhstan. Although each of these schools have their own peculiarities. The most popular schools in Kazakhstan are governmental schools that cover the main educational standard of the country. These schools are free of charge for students and have programs for students from the 1st grade up to 11th grade. For most Kazakhstani schools, STEM subjects, such as Biology, Physics, and Chemistry, start from the 7th grade. The second type of school is the specialized school for gifted children, these schools accept 6th, 7th, and 8th grade students by special entrance exams. These schools' teaching program is the same as the program of governmental schools, but the only difference of these schools: here the number of teaching hours per week of natural sciences subjects are greater than for other subjects. It means in specialized school for gifted children is designed to provide "additional" (in-depth) training for students at natural science subjects. The third type of school is the gymnasium, it implements general educational programs of basic general and secondary education, providing additional (in-depth) training of students in social subjects. In Kazakhstan there are different types of private schools, each of them, beside the governmental study program, have their own trajectory of teaching. They adopt foreign countries' (mostly the UK's educational program) educational programs into the main educational program of Kazakhstan. Another type of school is the Intellectual Schools. This is a special school that was established in 2008, that has adopted the A-Level educational standard into the Kazakhstani educational program. These schools are special governmental projects aimed at developing the technical specialties of the country. Currently, we have 22 Intellectual schools countrywide and all of these schools are oriented to natural sciences. To enter these schools, students take an entrance exam at the end of 6th grade and start study at the beginning of 7th grade. All these schools are funded by the government, students who study there get meals, a uniform, and student accommodation for those students whose parental home is far away from the school.

According to the location of the school, we divided students into three groups: schools located in the city (CS), schools located in the villages (VS) far from the city, and the schools located near the city regions (NS), these schools are mainly located in the suburbs.

Since we have many specialties and job occupations of parents, we divided students by their parents' job occupation in three groups: Those who work for the government (GW), those who are self-employed (SW), and those who do not work (NW). Additionally, according to parents' education, we divided students according to whose parents have graduated from natural science specialty (NS), whose parents have a social science specialty (SS), and whose parents have not graduated from university (NG).

2.3. Data Collection

Data collection was provided by Google Forms online platform, STEM - CIS was sent to students by email. Students used their mobile phones and personal computers in order to answer the questions. The survey was completed by 398 students from grades 7 to 11 and was sent back to us via email. In the online questionnaire, participants were first asked the aforementioned demographics and then a set of, 5-point Likert scale, scaled questions (1 = "Strongly Agree", 5 = "Strongly Disagree") measuring their interest towards STEM subjects. Among our sample, 94 students were from 7th grade, 82 students from 8th grade, 50 students from 9th grade, 97 students from 10th grades, and 76 students from 11th grade. At the beginning of the survey all students were informed that the survey is voluntary and anonymous.

2.4. Data Analysis

All datasets were checked to normality by the Shapiro–Wilk test. Furthermore, for normally distributed samples we used one way ANOVA test, for non-normally distributed samples we applied non-parametric ANOVA, i.e., Kruskal–Wallis test. Students' responses about gender groups was analyzed by t-test, since here we have two independent samples. Correlation analysis was applied in order to know correlation between students' STEM career interest and students' grades.

3. Results

3.1. Career Interest According to Grade Levels

Our first research question was: how do students' STEM Career Interest change across grade level, for each STEM subject? In our sample, there were five grade levels. Depending on the assumptions, we carried out one way ANOVA (Table 1) or Kruskal–Wallis test (Table 2) to see students' interest change across grades in Science, Math, Technology, and Engineering subjects.

Table 1. The results of one-way ANOVA for technology.

	F	**df1**	**df2**	***p***
Technology	1.71	4	182	0.149

Table 2. Kruskal–Wallis test results for participants' scores in Science, Math, and Engineering part of the survey.

	χ^2	**df**	***p***	**ε^2**
Science	8.65	4	0.070	0.021
Math	27.51	4	<0.001	0.069
Engineering	5.85	4	0.210	0.014

The means of students' scores at different grade levels across subjects do not overlap. The smallest mean (2.83) was from 9th graders in engineering while the highest was from (3.80) from 11th graders in science (See Appendix A).

For moving to the inferential statistics stage, the normality of Career Interest survey scores was assessed. The Shapiro–Wilk test indicated that the scores were normally distributed for Technology (W(398) = 0.99, p = 0.11) and non-normally distributed for Science (W(398) = 0.99, p = 0.035), Math (W(398) = 0.99, p = 0.001), and Engineering (W(398) = 0.99,

$p = 0.015$). Since scores for the subject of Technology were normally distributed, we conducted one-way ANOVA.

One-way ANOVA results show (Table 1) that there was not a statistically significant difference in Technology scores between grade levels ($F(4, 182) = (1.71)$, $p = 0.149$).

As seen in Table 2 the only significant group difference is for Math scores ($p < 0.05$). We did pairwise comparisons to see the differences between the grades for the scores of the Math subject (Table 3).

Table 3. Pairwise comparisons—students' response to Math subject.

Math							
Grades		W	p	Grades		W	p
7	8	−6.119	<0.001	8	10	3.709	0.066
7	9	−3.673	0.071	8	11	5.988	<0.001
7	10	−1.774	0.719	9	10	1.957	0.638
7	11	0.966	0.960	9	11	4.254	0.022
8	9	2.210	0.522	10	11	2.526	0.382

For Math scores, significant differences are between 7 and 8 ($M_7 = 3.76$; $M_8 = 3.39$), 8–11 ($M_8 = 3.39$; $M_{11} = 3.79$), and 9–11 ($M_9 = 3.50$; $M_{11} = 3.79$) grades. In other words, in Mathematics subject, 7^{th} graders are significantly more interested in STEM than 8^{th} graders, 11^{th} graders are more interested than both 8 and 9 graders.

3.2. Career Interest According to Gender Groups

Our second research question was: how do students STEM Career Interest change across gender for each STEM subject? In our sample, there are 191 males and 208 females. For this case, we employed *t*-test in pursuit of our goal.

According to the descriptive statistics of our sample, males' mean for all subjects are higher than that of females. What is striking is that both females and males lowest mean in engineering (See Appendix B).

According to Shapiro–Wilk test the scores are normally distributed only for Technology ($W(398) = 0.99$, $p = 0.133$) and non-normal for other subjects; Science ($W(398) = 0.99$, $p = 0.029$), Math ($W(398) = 0.99$, $p = 0.001$) and Engineering ($W(398) = 0.99$, $p = 0.011$). So, for Technology, an independent sample t-test was carried out while for others Mann–Whitney U test was done.

According to Independent Samples, t-test for Technology scores there is no significant effect of gender, $t(398) = 1.90$, $p = 0.058$, despite males ($M = 3.42$, $SD = 0.654$) attaining higher mean scores than females ($M = 3.29$, $SD = 0.675$). For analyzing non-normally distributed scores we constructed Table 4.

Table 4. Mann–Whitney U test results for the gender groups.

		Statistic	p	Effect Size
Science	Mann–Whitney U	18,762	0.338	0.0555
Math	Mann–Whitney U	17,430	0.034	0.1226
Engineering	Mann–Whitney U	17,030	0.014	0.1427

For Math and Engineering subjects, scores are significantly different from each other for males and females ($p_{Math} = 0.034$, $p_{Eng} = 0.014$, respectively). For Math, males have more positive interest than females ($M_{male} = 3.68$; $M_{female} = 3.56$). Similarly, even though the mean scores are low, for engineering males have more positive interests than females ($M_{male} = 3.08$; $M_{female} = 2.88$).

3.3. Career Interest According to Number of Siblings

Our third research question was: is there any difference between students' STEM career interest according to the number of siblings in their families? We categorized the number of siblings in a family as 1–3, 4–5, and over 5.

Students' interest is changing for all STEM subjects for different numbers of siblings in a family. The smallest mean of our sample corresponds to 1–3 siblings in engineering (2.94) while highest again corresponds to 1–3 siblings (3.67) in science (See Appendix C).

The Shapiro–Wilk test indicated that the scores were not normally distributed for all subjects: Science (W(398) = 0.99, p = 0.015), Math (W(398) = 0.99, p = 0.001), Technology (W(398) = 0.99, p = 0.054), and Engineering (W(398) = 0.99, p = 0.002). So, for this case we provided Kruskal–Wallis test (Table 5). Kruskal–Wallis is the nonparametric alternative of ANOVA.

Table 5. Kruskal–Wallis test results for the number of siblings.

	X^2	df	p	ε^2
Science	6.062	2	0.048	0.01523
Math	3.830	2	0.147	0.00962
Technology	0.567	2	0.753	0.00142
engineering	1.188	2	0.552	0.00299

The Kruskal–Wallis test showed no significant differences between the groups (p > 0.05). Thus, we do not need to go further to detect the differences in students' interests for the number of siblings groups.

3.4. Correlation between Career Interest and Students' End of Term Marks

Our fourth research question was: is there any difference between students' STEM career interest and students' end of term marks? We searched the relationship between the scores we gathered from the career interest survey and the students' first semester end term marks of 2021–2022 academic year from the STEM subjects. The correlation results are presented in Table 6.

Table 6. Correlation matrix for the relationships between career interest and students' grades.

		Response in Science	Response in Math	Response in Technology	Response in Engineering
Marks in Physics	Pearson's r	0.266	0.143	0.082	0.038
	p-value	**<0.001**	**0.004**	0.101	0.447
Marks in Math	Pearson's r	0.272	0.291	0.114	0.084
	p-value	**<0.001**	**<0.001**	**0.023**	0.094
Marks in Chemistry	Pearson's r	0.188	0.108	0.106	−0.024
	p-value	**<0.001**	**0.031**	**0.034**	0.628
Marks in Biology	Pearson's r	0.155	0.058	0.108	0.018
	p-value	**0.002**	0.248	**0.031**	0.720

The significant correlations in Table 6 are in bold text. There is a significant and positive correlation (r = 0.266, p < 0.001; r = 0.143, p < 0.004) between students' grades in physics and their scores for the response to the Science and Math part of the survey, correspondingly. The Math grades are significantly related to students' responses to the Science, Math, and Technology sections of the survey. Chemistry grades are positively correlated with students' responses on the Science, Math and Technology sections of the survey. Students' biology grades are significantly correlated to Science and Technology scores from the survey. Finally, students' scores from the engineering items of the survey had no relationship with any STEM subject.

3.5. Career Interest According to Parents' Occupation and Education

Our fifth research question was: is there any difference between students' STEM career interest and parents' occupation? Students' parents' jobs were divided into three categories. Students' scores for these categories across subjects are indicated in Appendix D. The table includes data for fathers and mothers' jobs separately.

According to the descriptive data, those whose fathers are not working have the highest (3.70) interest score in Science and the lowest score (2.90) is in Engineering which corresponds to students whose fathers are not working. Likewise, the highest (3.74) and lowest (2.92) scores for mothers' jobs corresponds to mathematics-nonworking mothers, and engineering-mothers working for the government, respectively.

For the fathers' job scores the Shapiro–Wilk test indicated that the scores were normally distributed for the subject of Technology (W(398) = 0.995, $p = 0.25$) and non-normally distributed for Science (W(398) = 0.992, $p = 0.038$), Math (W(398) = 0.99, $p = 0.001$), and Engineering (W(398) = 0.99, $p = 0.002$). Since scores for Technology were normally distributed, we conducted One Way ANOVA and for others Kruskal–Wallis test.

For the mothers' job, the Shapiro–Wilk test indicated that the scores were also normally distributed only for the subject of Technology (W(398) = 0.995, $p = 0.252$) and non-normally distributed for Science (W(398) = 0.991, $p = 0.023$), Math (W(398) = 0.985, $p = 0.001$), and Engineering (W(398) = 0.989, $p = 0.004$).

As seen from Table 7, there is no significant difference in the subject of technology, neither for fathers' (F(2, 33.3) = (0.423), $p = 0.659$) nor for mothers' occupation (F(2, 99.5) = (1.89), $p = 0.157$). For both cases $p > 0.05$.

Table 7. The results of one-way ANOVA for the parents' occupation.

Fathers' Occupation	F	df1	df2	*p*	Mothers' Occupation	F	df1	df2	*p*
Technology	0.423	2	33.3	0.659	Technology	1.89	2	99.5	0.157

Furthermore, in Table 8, the Kruskal–Wallis test analysis results are shown for Science, Math, and Engineering subjects according to students' parents' job occupation.

Table 8. Kruskal–Wallis test results for the parents' occupation.

Fathers' Occupation	χ^2	df	*p*	ε^2	Mothers' Occupation	χ^2	df	*p*	ε^2
Science	0.809	2	0.667	0.002	Science	0.095	2	0.954	0.0002
Math	1.707	2	0.426	0.004	Math	5.238	2	0.073	0.013
Engineering	0.279	2	0.870	0.0007	Engineering	3.865	2	0.145	0.009

As seen from Table 8 there is no significant difference for subjects of Science, Math, and Technology neither for Fathers' nor for Mothers' occupation. For both cases, $p > 0.05$.

The second part of our fifth research question was: is there any difference between students' STEM career interest and parents' education? Parents' education was divided into three categories, those who graduated in Natural Sciences (NS), Social Sciences (SS), and Not Graduated (NG) from any university.

Descriptive data (Appendix E) showed that students whose fathers did not graduate from any university have the highest (3.73) interest score in science. Surprisingly, those students whose fathers graduated with Natural Science have the lowest score (2.87) in Engineering. For the case of the students' mothers' education, students whose mothers did not graduate from any university have the highest scores (3.71) in Math, whereas, students whose mothers did not graduate from any university and whose mothers graduated in Natural Sciences have the lowest scores (2.93 and 2.94 correspondingly) in Engineering. Inferential statistics regarding parents' education are presented in Tables 9 and 10.

Table 9. The Results of One-Way ANOVA for the parents' education.

Fathers' Education	F	df1	df2	*p*	Mothers' Education	F	df1	df2	*p*
Science	2.28	2	188	0.105	Technology	0.162	2	176	0.850
Technology	1.02	2	185	0.362					

Table 10. Kruskal–Wallis test results for the parents' education.

Fathers' Education	X^2	df	p	ε^2	Mothers' Education	X^2	df	p	ε^2
Math	2.82	2	0.244	0.007	Science	2.407	2	0.300	0.0063
Engineering	3.01	2	0.222	0.008	Math	1.375	2	0.503	0.0036
					Engineering	1.736	2	0.420	0.0046

According to the fathers' education, the Shapiro–Wilk test indicated that the scores were normally distributed for Science (W(398) = 0.992, p = 0.058) and technology (W(398) = 0.992, p = 0.067) subjects and non-normally distributed for Math (W(398) = 0.99, p = 0.001) and Engineering (W(398) = 0.99, p = 0.001). Since scores for Science and Technology subjects were normally distributed, we conducted one-way ANOVA and for others Kruskal–Wallis test.

For the mothers' education, the Shapiro–Wilk test indicated that the scores were normally distributed only for the subject of technology (W(398) = 0.99, p = 0.085) and non-normally distributed for Science (W(398) = 0.992, p = 0.045), Math (W(398) = 0.998, p = 0.001), and Engineering (W(398) = 0.987, p = 0.002).

As seen from Table 9 there is no significant difference in Technology neither for fathers' (F(2, 185) = (1.02), p = 0.362) nor for mothers' (F(2, 176) = (0.162), p = 0.850) education. For both cases $p > 0.05$. The same situation happened within Science for the fathers' education, (F(2, 188) = (2.28), p = 0.105), additionally, the p value is more than 0.105.

Table 10 shows the Kruskal–Wallis test analysis for Science, Math, and Engineering subjects according to students' parents' education.

Table 10 shows a high value of p ($p > 0.05$), which means there is no significant difference for Science, Math, and Technology subjects, neither for fathers' nor for mothers' education.

3.6. Career Interest According to School Type and Location

Our seventh research question was: is there any difference between students' STEM career interest and parents' education? From the descriptive data in Appendix F we can see that according to the school type, the governmental school students (GS) have the highest (3.73) interest score in Math, and the lowest score (2.91) is in Private school (PS) students in Engineering. In the case of school location, the highest (3.74) interest score is from students who study in Village schools (VS) in Science and the lowest score (2.95) is from students who study in the City Schools (CS) in Engineering.

The Shapiro–Wilk test indicated that for the school type the scores were normally distributed only for the subject of Technology (W(398) = 0.995, p = 0.247) and non-normally distributed for Science (W(398) = 0.99, p = 0.007), Math (W(398) = 0.985, p = 0.001), and Engineering (W(398) = 0.989, p = 0.005).

For the location of the school the Shapiro–Wilk test indicated that the scores were normally distributed only for the subject of Technology (W(398) = 0.994, p = 0.103) and non-normally distributed for Science (W(398) = 0.990, p = 0.009), Math (W(398) = 0.985, p = 0.001), and Engineering (W(398) = 0.988, p = 0.002). For normally distributed samples we conducted one-way ANOVA and for the non-normally distributed ones we provided Kruskal–Wallis test.

As seen from Table 11, p value is higher than 0.05 for both the school type (F(4, 138) = (0.836), p = 0.504) and school location (F(2, 80.8) = (1.70), p = 0.189), there is no difference between groups for Technology scores ($p > 0.05$).

Table 11. The results of one-way ANOVA for the school type and location.

School Type	F	df1	df2	p	School Location	F	df1	df2	p
Technology	0.836	4	138	0.504	Technology	1.70	2	80.8	0.189

Furthermore, for non-normally distributed data a Kruskal–Wallis (Tables 12 and 13) test was conducted for Science, Math and Engineering scores according to school type and school location.

Table 12. Kruskal–Wallis test results for the school type and location.

School Type	χ^2	df	p	ε^2	School Location	χ^2	df	p	ε^2
Science	20.40	4	<0.001	0.0513	Science	6.25	2	0.044	0.0157
Math	11.21	4	0.024	0.0282	Math	2.69	2	0.261	0.0068
engineering	1.55	4	0.817	0.0039	engineering	1.38	2	0.502	0.0035

Table 13. Pairwise comparisons—students' response to Math and Science subjects.

School Type								School Location			
Science		W	p	Math		W	p	Science		W	p
GS	GC	−1.044	0.948	GS	GC	−0.565	0.995	VS	CS	−1.96	0.348
GS	PS	−5.757	<0.001	GS	PS	−3.973	0.040	VS	NS	−3.67	0.025
GS	G	−1.828	0.696	GS	G	−1.952	0.641	CS	NS	−2.59	0.159
GS	IS	−0.658	0.990	GS	IS	−2.342	0.462				
GC	PS	−5.675	<0.001	GC	PS	−4.093	0.031				
GC	G	−1.329	0.882	GC	G	−1.943	0.645				
GC	IS	0.503	0.997	GC	IS	−2.343	0.461				
PS	G	2.987	0.215	PS	G	1.438	0.848				
PS	IS	5.720	<0.001	PS	IS	2.007	0.615				
G	IS	1.656	0.768	G	IS	0.022	1.000				

As seen in Table 12, the significant group differences for school type are in Math and Science scores ($p < 0.05$) and for the school location only Science scores are significant. Accordingly, we provided pairwise comparisons.

According to the school type for Science scores, significant differences exist between governmental schools and private schools ($M_{gov.sch}$ = 3.72; $M_{priv.sch}$ = 3.28); between special schools for gifted pupils and private schools (M_{GC} = 3.66; $M_{priv.sch}$ = 3.28); and between private schools and intellectual schools ($M_{priv.sch}$ = 3.28, $M_{intellect.sch}$ = 3.69). For the Math scores, significant differences are between governmental schools and private schools ($M_{gov.sch}$ = 3.72; $M_{priv.sch}$ = 3.28); and between special schools for gifted pupils and private schools ($M_{gifted.sch}$ = 3.66; $M_{priv.sch}$ = 3.28).

According to the school location for Science scores, significant differences are between village schools and near the city region schools ($M_{village.sch}$ = 3.74; $M_{outskirt.sch}$ = 3.45).

4. Discussion

4.1. Students' Grade Level and STEM Career Interest

We found that 7th graders' interest scores for Math careers were more than that of 8th graders. In Kazakhstan, in grade 7, Science subjects (such as Physics, Chemistry, and Biology) begin to be taught as separate subjects. Up until this grade, these subjects are combined into a single Science subject [47]. At this grade, children begin to become interested in STEM, because they learn about science and technology from a new and in-depth point of view [48]. Our research also yielded interesting results that 11th graders were significantly more interested in Math careers than both 8th and 9th graders. Anderman and Maehr [49] claim that students can gradually change their opinions at this age, especially during adolescence. In the case of Kazakhstan, the reason for this can be as follows: at the end of 11th grade, all Kazakhstani school students take an entrance test to universities. Mathematics is a compulsory component of this test for all respondents, therefore at grade 11, Mathematics becomes one of the most studied subjects [47].

Students' interest scores from other subjects (Science, Technology and Engineering) did not show any significant differences between grade levels. Koyunlu and Dökme [50] in their study showed that students' interest in STEM careers change across the grade level only on life sciences, not on the other sub- scales of STEM.

4.2. Students' Gender and STEM Career Interest

The finding obtained in the current study shows that boys have a more positive interest than girls in Math careers. Similarly, for Engineering, boys have more positive views than girls. Our finding corresponds with findings of Koyunlu and Dökme [50], in their study authors also found that boys studying in secondary school are more interested in STEM than their girl counterparts. The authors relate the lower interest of girls in STEM careers to family stereotype. Almukhambetova and Kuzhabekova [51] in their works made qualitative research about factors affecting Kazakhstani female students to enroll in STEM and came up with findings that there are sociocultural, labor market and regional influences. They found that girls in Kazakhstan are not supported by their family members in their STEM career choice. They claim that the majority of the participants in their study reported that at least one of their family members was against their choice of STEM career. Consistent with the result of Eagly [52], Kazakhstani girls are mostly affected by the stereotype of the sexual division of work, labor, and the gender role expectations. However, Almukhambetova and Kuzhabekova [51] emphasize that schools can positively affect girls' STEM career choice, by having teachers who are trained in using gender-responsive advising and instructional strategies. They claim that girls are able to do well in STEM fields, because they feel capable to achieve as much as their male peers. This conclusion was made after asking girls about their end of term mark in each STEM subject and their attitude to these subjects. They came up with the conclusion that teachers and parents must motivate girls toward STEM and talk more about successful women in STEM.

Our study showed that for Technology and Science there are no significant differences between gender groups, all respondents have a positive attitude for technology and Science. This may be because of increasing numbers of women in Science and Technology over recent decades [53]. Nowadays, with the development of the internet and social media Kazakhstani middle and high school girls are aware of that and they have equal chances as their boy counterparts in science and technology [51]. However, Rosser [53] claims that maintaining balances between career and family, time management, maintaining trust and respectability from colleagues of women in science are still associated with problems related to social status of the woman and stereotypical beliefs.

4.3. Students' Family Size and STEM Career Interest

Family plays a big role in students' career interest [54,55]. Schulenberg et al. [56] reported that family size can influence adolescent career choice, big families usually have less finance to aid the older children in attending higher education, when younger children may receive more financial support since the financial need is less once older children leave home.

Black et al. [57] found negative correlation between family size and children's education, they also emphasize that higher birth order has a significant and large negative effect on children's education. Lloyd [58] also claims that the relationship between family size and children's education is negative in most Asian countries. In our study, we tried to search if there is a relationship between family size and STEM career interest. Our results showed that there are no significant differences between these groups. Our study results correspond with the results of Ali et al. [59], in their study authors examined the opinions of 200 university students in Pakistan and their results show that family size does not play any role in students' career choice.

4.4. Students' End of Term Marks and STEM Career Interest

The current study showed that there is a significant and positive correlation between students' grades in Physics and their scores for the response to the science and Math part of the survey, respectively. The Math grades are significantly related to students' responses in the Science, Math, and Technology sections of the survey. Chemistry grades are positively correlated with students' responses in the Science, Math, and Technology sections of the survey. Students' biology grades are significantly correlated to Science and Technology scores from the survey. Finally, students' scores from the Engineering items of the survey had no relationship with any STEM subject. Overall, it is shown that students' end of term marks have positive correlation with students' STEM career interest [50,60]. Dabney et al. [61] emphasizes academic achievements of students as one of the main factors which stimulate youth interests toward STEM careers, as well as their self-belief and interest in science [62]. According to Rittmayer and Beier [63], students with high academic achievement will motivate themselves to set challenging goals; strive to achieve them and are most interested to choose STEM as their future career. Additionally, students who have been involved in STEM since their school years are able to anticipate academic achievement beyond past achievement because students who feel confident in STEM are more inspired to succeed [63].

4.5. Students' Parents' Occupations, Educations, and STEM Career Interest

All parents want a bright future, a secure and luxurious career for their children. Since parents want their children to be successful, they also become depressed if their children choose the wrong career. That is why parents do everything possible to find a worthy profession for their children [64].

Despite the fact that many studies suggest that parents play a huge role in students career choice [65,66], the result of our study showed that there is no significant difference between groups for STEM subjects neither for fathers' nor for mothers' job occupation and education. Our results are consistent with findings of [67,68]. Lichtenberger and George-Jackson [69] suggest that family awareness of STEM careers and their conscious efforts to increase their children's interest and skills in STEM fields have a greater influence on their children's career choices than their education and socio-economic level. This finding was also confirmed by Nugent et al. [70]. Chachashvili-Bolotin et al. [71] found that the parents' education highly affects students' interest in studying at the university, but not for the choice or the direction of study.

4.6. Schools Type and Location and STEM Career Interest

In our sample, there is no difference between groups for technology scores, according to school type and school location. For Science scores, according to the school type: students of special schools for gifted pupils, governmental school students and intellectual school students have a more positive attitude to STEM careers than private school students. For the Math scores: students of special schools for gifted pupils and governmental school students have a more positive attitude to STEM careers than private school students. From these findings we can conclude that students from schools which are financially supported by the government have a more positive attitude to STEM careers than students who study in paid schools, because in Kazakhstan all private schools are paid schools. This may be according to the economic status of students' parents. Students who are studying at private schools in Kazakhstan can be related to the higher economic status of families, because in Kazakhstan tuition payment for private schools can vary from USD 250 to 1000 per month while the living wage in Kazakhstan is USD 78.72 per month [72]. Students who are studying in private schools prefer a future career: business, entrepreneurship, law, finance, etc., rather than STEM [73–75]. This finding was also confirmed in some other papers [68,69], they found that economically disadvantaged students tended to have more trust in STEM majors, more than their high-income counterparts.

According to the school location for science scores, significant differences are between villages schools and near the city region schools. Village school students have a more positive attitude to STEM careers than near city region school students. This result is consistent with results of Chachashvili et al. [71], they found those students who live in a village have more interest in STEM careers. Peterson et al. [76] explained this relation in their work as rural communities believe that STEM education can solve some of their very difficult economic and social problems, therefore most rural students are interested in STEM careers [76,77].

5. Conclusions

In conclusion, this study shows the factors which may affect middle and high schools' interest toward STEM as a choice for their future career. The results of the currents study is relevant for the case of Kazakhstan, since very few researchers studied STEM education in Kazakhstan. In this study, we tried to cover broad factors that may affect students' STEM career interest and our findings were consistent with results of other researchers in different countries. Generally, all inquired students' interest about STEM careers were positive. In particular, boys and girls responses were equally positive in many sub-scales of STEM-CIS. Additionally, great interest to STEM career were shown by village students, whereas private school students', who are living in the city, STEM career interests were the lowest in our sample. We also found that students' family size, parents' education, and job occupation does not relate students' STEM career interest.

According to the growing interest toward STEM in Kazakhstan our findings may be helpful for researchers in their further in-depth study, educational policy makers, and curriculum developers during implementing STEM programs into curriculum.

As the limitation of our study, we can report about sample size, data were collected from about 400 students. Small sample size may deflect the real picture of the study. Additionally, since surveys were provided online, some students could make arbitrary choices while answering. As quantitative research results may not give in-depth results, we suggest for other researchers to provide qualitative study.

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Data Availability Statement: Data will be provided upon request. Any reader can request the data.

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Appendix A. Career Interest According to Grade Levels

Table A1. Descriptive statistics for participants', STEM—CIS, scores regarding their grade levels.

	Grade	N	Mean	SD		Grade	N	Mean	SD
Science	7	94	3.63	0.612	**Technology**	7	94	3.34	0.694
	8	82	3.52	0.590		8	82	3.22	0.608
	9	50	3.57	0.503		9	50	3.32	0.592
	10	97	3.60	0.653		10	97	3.45	0.649
	11	76	3.80	0.663		11	76	3.41	0.748
Math	7	94	3.76	0.621	**Engineering**	7	94	2.98	0.751
	8	82	3.39	0.622		8	82	2.92	0.730
	9	50	3.50	0.491		9	50	2.83	0.704
	10	97	3.60	0.691		10	97	2.93	0.828
	11	76	3.79	0.713		11	76	3.20	0.919

Appendix B. Career Interest According to Gender Groups

Table A2. Descriptive statistics for participants' STEM—CIS scores regarding gender groups.

	Gender	N	Mean	SD		Gender	N	Mean	SD
Science	Male	191	3.65	3.64	**Technology**	Male	191	3.42	3.45
	Female	208	3.60	3.64		Female	208	3.29	3.27
Math	Male	191	3.68	3.73	**Engineering**	Male	191	3.08	3.00
	Female	208	3.56	3.64		Female	208	2.88	2.82

Appendix C. Career Interest According to Number of Siblings

Table A3. Descriptive statistics for participants' STEM—CIS scores regarding the number of siblings in families.

	Number of Siblings in Families	N	Mean	SD		Number of Siblings in Families	N	Mean	SD
Science	1–3	214	3.67	0.597	**Technology**	1–3	214	3.35	0.650
	4–5	156	3.60	0.656		4–5	156	3.36	0.705
	More than 5	29	3.39	0.533		More than 5	29	3.33	0.595
Math	1–3	214	3.60	0.634	**Engineering**	1–3	214	2.94	0.803
	4–5	156	3.67	0.698		4–5	156	3.02	0.829
	More than 5	29	3.49	0.604		More than 5	29	3.03	0.591

Appendix D. Career Interest According to Parents' Occupation

Table A4. Descriptive statistics for participants' STEM—CIS scores regarding parents' occupation.

	Father's Job Occupation	N	Mean	SD		Mother's Job Occupation	N	Mean	SD
Science	GW	198	3.62	0.618	**Science**	GW	276	3.61	0.615
	SA	160	3.61	0.622		SA	54	3.62	0.627
	NW	13	3.70	0.547		NW	62	3.63	0.660
Math	GW	198	3.58	0.650	**Math**	GW	276	3.57	0.675
	SA	160	3.67	0.646		SA	54	3.72	0.579
	NW	13	3.67	0.547		NW	62	3.74	0.626
Technology	GW	198	3.32	0.672	**Technology**	GW	276	3.31	0.646
	SA	160	3.39	0.666		SA	54	3.52	0.778
	NW	13	3.36	0.626		NW	62	3.38	0.628
Engineering	GW	198	3.00	0.828	**Engineering**	GW	276	2.92	0.784
	SA	160	2.98	0.803		SA	54	3.11	0.893
	NW	13	2.90	0.601		NW	62	3.12	0.786

Appendix E. Career Interest According to Parents' Education

Table A5. Descriptive statistics for participants' STEM—CIS scores regarding parents' education.

	Father's Education	N	Mean	SD		Mother's Education	N	Mean	SD
Science	NS	85	3.53	0.627	**Science**	NS	134	3.59	0.666
	SS	180	3.62	0.614		SS	177	3.69	0.532
	NG	96	3.73	0.629		NG	70	3.66	0.682
Math	NS	85	3.55	0.622	**Math**	NS	134	3.63	0.674
	SS	180	3.63	0.652		SS	177	3.61	0.611
	NG	96	3.69	0.668		NG	70	3.71	0.728
Technology	NS	85	3.24	0.729	**Technology**	NS	134	3.35	0.691
	SS	180	3.37	0.653		SS	177	3.38	0.629
	NG	96	3.38	0.654		NG	70	3.32	0.731
Engineering	NS	85	2.87	0.840	**Engineering**	NS	134	2.94	0.818
	SS	180	3.03	0.783		SS	177	3.03	0.783
	NG	96	3.01	0.825		NG	70	2.93	0.831

Appendix F. Career Interest According to School Type and Location

Table A6. Descriptive statistics for participants' STEM—CIS scores regarding school type and location.

	School Type	N	Mean	SD		School Location	N	Mean	SD
Science	GS	56	3.72	0.604	**Science**	VS	55	3.74	0.580
	SSGCh	150	3.66	0.610		CS	303	3.62	0.636
	PS	39	3.28	0.456		NCRS	41	3.45	0.509
	G	47	3.52	0.721					
	IS	107	3.69	0.606					
Math	GS	56	3.73	0.588	**Math**	VS	55	3.72	0.575
	SSGCh	150	3.69	0.662		CS	303	3.61	0.690
	PS	39	3.40	0.542		NCRS	41	3.56	0.496
	G	47	3.56	0.735					
	IS	107	3.57	0.675					
Technology	GS	56	3.28	0.661	**Technology**	VS	55	3.25	0.664
	SSGCh	150	3.37	0.683		CS	303	3.38	0.675
	PS	39	3.24	0.540		NCRS	41	3.24	0.595
	G	47	3.33	0.674					
	IS	107	3.42	0.688					
Engineering	GS	56	3.09	0.859	**Engineering**	VS	55	3.08	0.827
	SSGCh	150	2.96	0.820		CS	303	2.95	0.809
	PS	39	2.91	0.682		NCRS	41	3.06	0.686
	G	47	2.96	0.936					
	IS	107	2.98	0.718					

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