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Factors affecting the decision of female students to enrol in undergraduate science, technology, engineering and mathematics majors in Kazakhstan

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ABSTRACT

Using the qualitative interview-based research design approach, this study analyses the experiences of female students currently enrolled in science, technology, engineering and mathematics (STEM) disciplines in the universities in Kazakhstan. More specifically, this study aimed to explore the experiences of the students in the process of transition to postsecondary education and the factors related to their decision to enrol into STEM majors. The results of the study are useful for understanding the barriers, which affect the transition of women through the STEM pipeline in non-Western traditional societies and have some important implications for research on gender issues in STEM education in the post-Soviet and larger international contexts.

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Introduction

Despite the growing participation of women in higher education, the percentage of women pursuing education in STEM continues to decline (UNESCO, 2016). In 2015, more than half of the European countries reported having no more than 45% of their science and engineering workforce represented by women (European Commission, 2016). The situation in Asia is even more adverse given that women constituted only 18% of the science and engineering workforce according to UNESCO's report on girls and women in STEM in Asia (2017).

Given that economic competitiveness of most contemporary economies depends on effective utilisation of its talented and productive workforce, as well as on the ability to capitalise on diversity (UNESCO, 2017), this underrepresentation of women in STEM fields is internationally recognised as an important problem, which requires an in-depth understanding to be addressed (OECD, 2009, 2012).

In order to resolve the problem of underrepresentation of women in STEM occupations, it is important to understand what unique barriers and challenges female students face in the process of choosing STEM education and subsequently career track, as well as what experiences women have while pursuing education and careers in STEM. This study focuses, in particular, on the early stage of STEM pipeline- the period when girls transition

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from high school to undergraduate education in STEM majors. More specifically, the study attempts to understand which factors influence female students' decision whether to pursue STEM majors.

There is an important reason why this study focuses on the early stage in the STEM pipeline. Prior research shows that the loss of women from STEM-related occupations start as early as school years when they begin to participate less in STEM-related in-school and after-school activities than boys (Blickenstaff, 2005) and when they shy away from continuing further in STEM undergraduate majors (Burke & Mattis, 2007; Ceci et al., 2014). This loss has significant implications down the pipeline as girls continue to drop from STEM majors during their university education and from STEM careers after graduation (Hill et al., 2010). Prior studies showed that it is important to start to address the 'leaky pipeline' problem as early as possible (Blickenstaff, 2005; Whitelegg, 2001).

Focusing on the early stage of the pipeline is also important from the point of view of scholarly contribution. Within the body of research on persistence and completion in STEM fields, insufficient attention is given to researching the experiences of female high-school graduates girls in the transition to STEM education (Moakler, & Kim, 2014). While there are some studies, which explore demographic factors, to a lesser extent the literature is concerned about the recruitment factors influencing STEM entrance, which are beyond demographics (Wang, 2013). In addition, little attention has been paid to the stage in the non-Western contexts. The study will fill the existing niche by exploring both demographic and non-demographic factors affecting girls' decision to pursue undergraduate STEM majors in the previously unexplored context of post-Soviet Kazakhstan.

Background information about women in STEM education in Kazakhstan

During its more than twenty years of independence, Kazakhstan has taken significant steps to advance the status of women (ADB, 2016). Kazakhstan has adopted several gender equality laws, including a new 'Law on Equal Opportunities for Men and Women' (OECD, 2014). As a result of government's efforts to improve the gender equality, the World Economic Forum ranks Kazakhstan 47th out of 145 countries on the Gender Gap Index and 52nd out of 155 on the Gender Inequality Index (World Economic Forum, 2016), which is the highest position among other Central Asian countries.

Kazakhstan scores particularly high in women's educational attainment. The latest data suggests that women outnumber men at all levels of education. In higher education, for instance, women represented 57.2% of all undergraduate students and 60% of all Master students in 2016 (Ministry of National Economy of the Republic of Kazakhstan Committee on Statistics, Astana, 2016). However, these positive indicators of women's participation in higher education do not correspond to the enrolment patterns in STEM majors. Kazakhstani women tend to have lower enrolment rates in STEM disciplines at the higher education level and also are more likely to 'leak' from the STEM educational pipeline as they advance in their education. For instance, the natural sciences are dominated by male students with 31.6% of female students enrolled in these fields, whereas in the humanities, the percent of female students is 74.2% (ADB, 2016). Engineering, manufacturing and construction disciplines in Kazakhstan are also male-dominated and female students make up only 31.88% of the overall population of

undergraduate students in these fields (UNESCO Institute of Statistics, 2016). Male students are more likely to choose STEM majors, particularly those connected to hydrocarbon and energy industries and other fields which are experiencing growth, while female students predominate in humanities, healthcare and public sector majors (ADB, 2016).

While in many countries, one of the main reasons for low enrolment of women in STEM majors is the lower achievement of girls in STEM fields at the high-school level (UNESCO Institute of Statistics, 2016), this reason does not apply to Kazakhstan. Internationally, gender differences in STEM start to be noticed in the performance of 15-year-old students in international assessments in such disciplines as Math and Science (UNESCO Institute of Statistics, 2016). In Kazakhstan, girls are doing equally if not better than boys at the high-school level. In such well-known international assessments as PISA and TIMSS Kazakhstani female students consistently display equal scores with male students in mathematics and outscore male students in science (UNESCO Institute of Statistics, 2016).

Another notable thing about Kazakhstan is that the government of the country pursues a very active innovation development policy and makes lots of efforts to attract both men and women into STEM fields, which experiences a deficit of qualified cadre, to popularise innovation-related priority areas of development and to improve STEM education (State Program of Education and Science development 2016–2019). For example, it supports a broad network of specialised schools offering intensive training in STEM fields (Almukhambetova & Hernandez Torrano, 2020), which have an almost equal enrolment of girls and boys. The government also offers a significant number of scholarships for the students willing to enter the STEM majors.

Despite all these efforts of the government, women still remain underrepresented in STEM majors at universities. Put together; this makes the early stage of the STEM pipeline very important to explore in the context of Kazakhstan. The unusual disparity between the level of attainnment of high-school girls in STEM subjects, the availability of government scholarships and undererollment of girls in undergradiate STEM majors make Kazakhstan an interesting case with a high revelatory potential, which can bring important insights for other countries.

Review of Western research on women's experiences in STEM

There is a substantial empirical effort to understand the multitude of influences that can shape women's experiences in STEM education and careers. To describe the phenomenon of women's attrition from education and careers in STEM fields researchers use the 'the leaky pipeline' metaphor and most studies try to understand what happens to women as they progress through the pipeline and which factors may contribute to their loss from it (Blickenstaff, 2005; Burke & Mattis, 2007; Etzkowitz et al., 2000). The 'pipeline' research suggests that, in Western industrial societies, women, unlike men, systematically drop out from their educational and occupational tracks at some critical periods starting from school through mid-career (Hill et al., 2010; Powell et al., 2000). Many research studies pointed out to a variety of factors that influence the gendered pattern of career and educational progression in STEM fields (Burke & Mattis, 2007; Wang, 2013). In terms of stages in the pipeline, the factors are often grouped into factors of recruitment

and factors of retention, while in terms of types of influences involved, the factors are classified into individual, institutional and environmental (Heilbronner, 2011).

Many of the studies focusing on women's experiences in STEM fields use Lent, Lent et al.'s (1994, 2000) social-cognitive career theory as an organisational and interpretative framework (Fouad & Santana, 2017). This theory explains educational experiences and career of women in STEM fields in terms of social influences on a woman and the woman's cognitive processes of making sense of the influences, which, in their turn, affect and are affected by the experiences in various identity structures (Lent et al., 2000). According to the theory, a variety of factors shaping the experiences and decisions of a girl pursuing education and careers in STEM fields can be classified into individual and environmental, whereby individual refer to specific individual's characteristics, self-concepts and abilities, while environmental refer to any social influences, which may, in their turn, shape the individual characteristics (Lent, 2005; Wang, 2013). The environmental influences may further be divided into institutional and societal, whereby institutional refer to any influences related to the school or university, which the girl is attending, while societal influences refer to factors beyond the educational organisation (Lent et al., 2000).

Some of the individual micro-level influences, which have been shown to have an impact on the experiences of women in STEM fields include the psychological factors, which affect the girls' engagement in STEM (UNESCO, 2017). Among these factors, women's self-perceptions of their abilities are particularly important (Dasgupta & Stout, 2014). Despite their strong aptitudes in sciences and math, girls often have a lower level of confidence in STEM subjects than boys (Stoet & Geary, 2018). Before choosing the major, the girls often hold the socially instilled perceptions that STEM subjects are difficult and they will not be able to perform equally well with male students in STEM disciplines (Shillabeer & Jackson, 2013). Furthermore, research suggests that those girls who assimilate such negative perceptions have lower aspirations for STEM careers while the girls who are more confident in their math and science abilities are more likely to choose the STEM-related majors (UNESCO, 2017).

The literature on gender differences in occupational interests suggests that interest plays a critical role in occupational choices (Su et al., 2009). A number of studies report that young women are more interested in jobs which involve social interactions and value the altruistic and social rewards whereas the young men are more interested in occupations which involve working with physical objects and are more driven by such extrinsic rewards as earning high salaries and gaining power (Eccles, 1994; Konrad et al., 2000). The STEM careers are perceived by young women as not associated with communal goals and these misperceptions make females disregard STEM careers (Dasgupta & Stout, 2014). As a result of the low confidence and interest level, girls are less likely to enrol in STEM subjects at the high-school level, especially in subjects, which are later required for enrolling in college-level engineering, physics and computer science courses (Perez-Felkner et al., 2019).

The research reviewed also identifies a multitude of mezo-level school and family-related factors that influence the gendered patterns in STEM fields (Burke & Mattis, 2007; Wang, 2013). Among the school-related factors, the research has pointed out such factors as teaching quality and effective teaching strategies (UNESCO, 2017). The female students attending the schools with a higher quality of teaching and effective learning environment reported more confidence in science and math (Heaverlo et al., 2013; Spearman & Watt, 2013). The studies also show that teachers' perceptions of students' ability in Math and

science are often gender-biased and the girls tend to receive less encouragement from teachers in STEM subjects (Keller, 2001). The employment of female teachers was found to have a particular influence on girls' engagement in STEM (Elstad & Turmo, 2009). The research identified that such issues as lack of female faculty who could serve as role models and mentors for female students and lack of teacher-student interactions in Math and science classes might discourage the women from choosing the STEM disciplines as majors (Powell et al., 2000). Classroom observations in some contexts have also revealed that girls tend to ask less questions in class and are more likely to get less feedback and support from the teachers (Heaverlo et al., 2013). Furthermore, their confidence and feeling of belonging to STEM field is to a greater extent affected by the peer relationships. The studies identified that supportive peers and collaborative classroom climate can predict the girls' interest and engagement in STEM (Dasgupta & Stout, 2014).

Among other school-related factors the availability of resources to stimulate girls' interest in science and the access to informal STEM activities were found to have a positive impact on girls' achievement in science (Dasgupta & Stout, 2014). Those female students who did not have enough background to major in STEM due to insufficient resources in their secondary schools to support their interest and skills in science and mathematics (Parsons, 1997) and had limited out-of-school STEM experiences (McCormick & McCormick, 1991) were less likely to choose the STEM college major.

Among the family-related factors, the research identifies the influence of such factors as parents' education level and the presence of family members working in the STEM field. In general, the parents were found to have a profound influence on their daughters' educational and career tracks. The studies show that children of more educated parents are more likely to take advanced courses in Math and science and perform better (Jodl et al., 2001; OECD, 2016). The girls whose parents are employed in STEM, are also more likely to choose a STEM major and pursue career in STEM (Shapiro & Sax, 2011) as the parents working in STEM industries can familiarise the girls with STEM profession and discredit the belief that STEM professions are difficult to combine with family life (Tenenbaum & Leaper, 2003). The research also suggests that parents' beliefs and expectations about STEM have a significant impact on girls' occupational choices and mothers' support, in particular, can play a critical role in developing the girls' motivation to persist in STEM (Yee & Eccles, 1988). In some contexts, the parents tend to have lower expectations of girls' abilities to succeed in STEM and to place less value in their choice of STEM careers (Tenenbaum & Leaper, 2003). The research has also identified that the more parents encourage their children' after-school activities related to STEM and provide necessary support and materials, the more they become interested in STEM (Simpkins et al., 2006).

Some of the larger (macro-level) influences also play a major role in determining girls' decisions to enrol to STEM majors. Accumulated empirical evidence suggests that societal and cultural norms, gender roles stereotypes and expectations, as well as the stereotypes associated with STEM and gendered culture of STEM fields are considered to be major factors contributing to gender disparity in STEM at higher education level. One of the well-documented stereotypes the girls face is the stereotype regarding women and their abilities to perform well in STEM (Bench et al., 2015; Shapiro & Williams, 2012), especially, in such STEM fields as engineering and computer science (Master et al., 2016). The stereotypes about women's abilities in STEM can affect the evaluations of students and decrease mentorship opportunities for girls (Moss-Racusin et al., 2012). Another stereotype mentioned in the

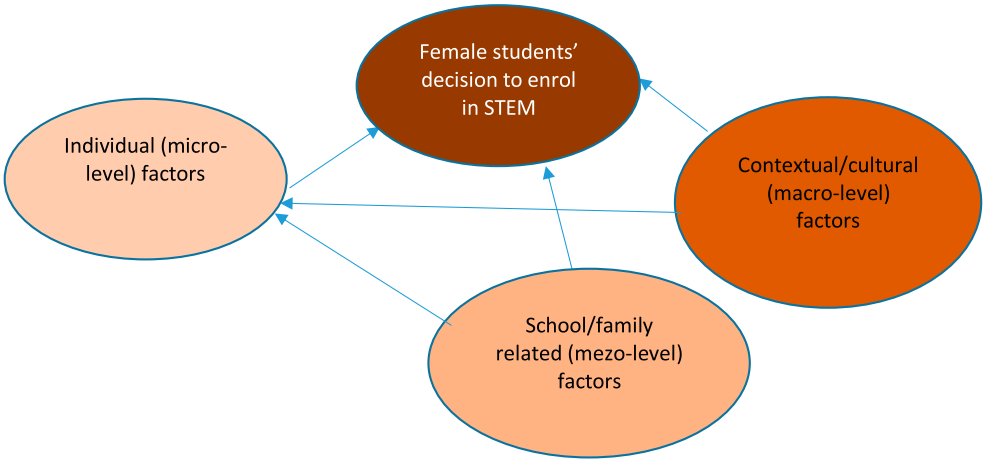

Figure 1. Factors related to female students' decision to enrol in STEM undergraduate majors

literature is the stereotype about women's appearance and those girls who look very feminine are perceived as not to be well-suited for science (Banchefsky et al., 2016; Goldman, 2010). In sum, these stereotypes and societal norms have far-ranging effects and can decrease the expectations of success among girls (Eccles, 1994) and alter girls' goals and interest in pursuing STEM careers (Diekman et al., 2010). Research also suggests that cultural, regional and ethnic variation in gender-STEM stereotypes has not been widely studied to date.

The visualisation in Figure 1 summarises a variety of individual, institutional and environmental factors, which shape the experiences of women in STEM fields. This conceptual framework, guided by the SCCT, will be used in the design and interpretation of the study results.

This study is intended to improve the understanding of the important experiences of girls in the process of transition to STEM postsecondary education as well as the factors that determine their decision to pursue a STEM major by pproviding an answer to the following research questions:

RQ1. What are the experiences of female higher education students in transition to STEM post-secondary education?

RQ2. What are the factors that shape their decision to enroll to a STEM major?

(a) What are the individual (micro-level) factors?
(b) What are the family-related (mezo-level) factors?
(c) What are the institutional (mezo-level) factors?
(d) What are the larger (macro-level) factors?

Methods

To answer the research questions, we conducted a qualitative inquiry (Creswell, 2002) into experiences of girls pursuing education in STEM disciplines in the universities in Kazakhstan. The main method of data collection within the design was semi-structured interviews conducted face-to-face or by Skype. The interviews were chosen as a method because they

allow a researcher to understand the experiences of the participants in words of the participants themselves (Creswell, 2013). Their semi-structured format allowed to combine organisation of the interview around themes emerging from the literature and flexibility to dynamically follow up on unexpected themes.

A purposeful maximal variation sampling was used as the main approach to choosing the participants of the study. This approach allowed to achieve a greater variation in the experiences of STEM female students (Creswell, 2013). A total of 29 female students enrolled in various STEM majors in 10 universities in the North, South, East, West and Central Kazakhstan were interviewed. The participants varied on the following characteristics: (1) location of the university; (2) type of university; (3) STEM major; (4) year of study; (5) age; (6) region of home residence; (7) type of school attended.

We identified the technical universities and comprehensive universities with STEM departments in Kazakhstan from which the participants were to be selected. The majority of potential participants were recruited with snowballing techniques. Subsequently, an invitation explaining the purpose of the study was sent to female students pursuing education in STEM majors in these universities. The final participants were selected from those girls who agreed to participate in the study.

Our sample was relatively balanced on such characteristics as the type of university attending (14 students enrolled in technical universities and 15 students in comprehensive universities) and STEM majors. There was an overrepresentation of girls on such characteristics as a region of study and year of study, with the majority of participants representing Central Kazakhstan and 12 participants who were in their third year at university. In addition, the majority of study participants (17 girls) graduated from STEM-focused schools. Table 1 provides a summary of the demographic characteristics of the participants:

Each interview was conducted for about an hour and a half by one or two members of the research team and was recorded with permission from the participant. Prior to the interview, the participants were informed about the purposes of the study, risks and benefits of participation, as well as their rights, withdrawal and confidentiality procedures.

The questions in the interview asked about three types of factors-individual, institutional and environmental, The protocol of the interview included questions about the factors that shaped the female students' decision, about the people who influenced their choice as well as questions about challenges and opportunities in the decision-making process. In this paper, we are describing mostly the factors, which were identified in the process of analysis. The recordings from the study were transcribed and analysed using qualitative coding guided by the literature-based conceptual framework and the SCCT. To assure the trustworthiness of the data, the research team applied the member checking as suggested by Lincoln and Guba (1985). During each interview the notes were taken and then the interviews were discussed within 3 members of the research team who were collecting the data. All outstanding questions were identified by the research team members and in case there was a lack of clarity, the participants were contacted to clarify if the team members understood the issue correctly.

Results

The results of the study are presented around six main themes: (1) individual factors (2) family-related factors (3) school-related factors (4) contextual/cultural factors and influences (5) regional differentiation in students' experiences.

Table 1. Participants' background information

Code	Location of university	Type of university	Major	Year	Age	Region of Home residence	Type of School Attended
U1	Center	Comprehensive	Mathematics	2	19	South	STEM school
U2	Center	Comprehensive	Civil Engineering	3	19	North	STEM school
U3	Center	Comprehensive	Mechanical Engineering	3	19	East	STEM school
U4	Center	Comprehensive	Mathematics and Computer Modelling	2	18	North	STEM school
U5	Center	Comprehensive	Mathematics and Computer Modelling	2	18	West	STEM school
U6	Center	Comprehensive	Electrical and Electronic Engineering	3	19	South	STEM school
U7	East	Technical	Electrical Engineering	1	18	East	Non-STEM school
U8	East	Technical	Mathematics and Computer Modelling	1	18	East	STEM school
U9	Center	Comprehensive	Electrical and Electronic Engineering	3	19	North	STEM school
U10	Center	Technical	Machinery and Equipment	4	21	North	Non-STEM school
U11	East	Technical	Mathematics and Computer Modelling	1	18	East	Non-STEM school
U12	Center	Comprehensive	Nuclear Physics	4	21	Center	STEM school
U13	East	Technical	Metallurgy	2	19	East	Non-STEM school
U14	West	Technical	Port engineer/ mechanics	2	19	West	STEM school
U15	South	Comprehensive	Radio Electronics	3	19	South	STEM school
U16	South	Comprehensive	Technical Physics	2	19	West	Non-STEM school
U17	South	Comprehensive	Mechanics	4	22	South	STEM school
U18	North	Technical	Mineral Processing	3	20	South	Non-STEM school
U19	Center	Technical	Electric Power Engineering	3	19	North	STEM school
U20	North	Technical	Mineral Processing	3	20	South	Non-STEM school
U21	South	Comprehensive	Nuclear Physics	5	22	South	STEM school
U22	North	Technical	Mineral Processing	3	20	South	Non-STEM school
U23	West	Technical	Port engineer/ mechanics	3	20	West	Non-STEM school
U24	West	Technical	Port engineer/ mechanics	3	20	South	STEM school
U25	South	Comprehensive	Physics Engineering	4	22	South	STEM school
U26	West	Comprehensive	Transportation	3	21	West	Non-STEM school
U27	West	Technical	Geology	4	22	West	STEM school
U28	West	Technical	Geology	4	22	West	Non-STEM school
U29	South	Comprehensive	Information Systems	1	18	South	Non-STEM school

Individual (micro-level) factors

It seems that one of the most important individual factors, which affects girls' transition to STEM majors at universities, is self-efficacy (Pajares, 2005). Five interviewed girls reported having a low level of self-confidence at school. Five other participants mentioned that they constantly needed to 'prove their worth' to surrounding people teachers, parents, peers and, most importantly, to themselves. Three participants mentioned that they questioned

their abilities, doubting their 'fit' for an intended specialty. According to the participants, they used to prove their abilities when they were at school and they continue to do so at the university level. As one of the participants comments: 'When I participated in Olympiads in Physics and people could ask: (Do) you really do well in Physics?' 'Yes, I am good at Physics', then they were very surprised.'

However, despite the lower self-esteem at school, many girls that we interviewed reported having a good level of confidence in their STEM abilities and good content knowledge to perform well in STEM. Fourteen participants reported being very confident in their choice of major and resilient to challenges they face in transition to STEM postsecondary education. As one of the participants noted:

> If the girl is confident, no external factors can make a change. I studied 11 years at school and then entered the university. If the girl knows what she wants, nothing can influence her decision.

When asked about reasons for pursing a STEM major, these participants reported having high educational and career aspirations at the time of choosing their major. For example, one of the girls wanted to become a lead engineer in the seaport in her hometown, another has a dream to build a space rocket, one of the participants dreams to become a part of the mission to Mars. The participants shared that the goals they have set for themselves motivated them in their studies.

Family-related (mezo-level) factors

The analysis of the interviews revealed that family related factors are significantly influencing the female students' enrolment in STEM-related fields. About 66% of the participants had a family member working in STEM fields. 28% of participants indicated that their interest in STEM was based on the family member, working at the STEM field. The participants shared that they 'have been inspired by their example' and wished to continue the dynasty. As one of the participants commented:

> My grandmother was an architect and my grandfather was a civil engineer. My grandmother used to tell me the stories of how they worked together, how she designed the houses and my grandfather built them … I liked those stories very much. I think that is why I chose my specialty.

The interesting detail is that several participants shared that their parents advised them to choose the STEM career track as they will be able to help them to find the job in the field.

It was also identified that support and encouragement from a male family member were particularly important in the process of choosing the future specialty. If a father or elder brother supported their decision, the girls felt more confidence in their choice. As one of the girls commented:

> My elder brother is electrician. From my childhood I liked to watch him doing something … I also liked to disassemble the things to look what's inside and then assemble them together. My brother then asked me whether I want to become an electrician, too.

One interesting context specific finding emerging from our analysis is that several interview participants who were from the families with no boys shared that they used to be very close to their fathers from their childhood and used to do 'the men's work about the house'. One of such participants from a family with five daughters shared that she

has been very special to her father and he gave her a name, which in translation from Kazakh meant 'should be born as a boy.' Those participants reported that they had been supported by their fathers to choose a STEM career track:

> I used to be very close to my father, I was always with him. He loved me more than others … he used to say that I need to have high achievement in Math, higher than other students in order to enter a technical major. Probably because he wanted me to earn more in future … That's why I have chosen a mineral processing engineering major.

> I was both a girl and a boy in the family. We used to repair the car and things in the house with my father. I think this is how I developed my interest in STEM.

> I have always felt a great support from my father. He used to say: 'My daughter is the best, she is so smart and beautiful.' I respect him a lot … We used to talk a lot about science, about biology.

This unique treatment of some daughters as sons might have stemmed from the old tradition in Kazakh families with no son to dress one of the daughters as a boy. Such a girl was usually very close to her father and usually was taught how to ride a horse and shoot a bow. Such girls were very confident in themselves and were treated differently by the family and clan members and could even become famous warriors or clan leaders.

Another interesting context-specific finding from our study is that the girls from a single parent family were also more likely to choose the STEM major. As one of such participants explained that she was subconsciously trying to take the 'breadwinner's role' in the family, which they modelled after their own mothers, who had to assume such a role in the absence of a husband: 'I study here partly because I want to provide my mother with everything she want in the future … SHE is my motivation.' Two participants from single parent families shared that their mothers were very successful in their careers and they have been inspired by their strong personality traits. The participants reported that their mothers held very high expectations towards them, provided lots of support and served as role models for them.

More often than not, however, girls in Kazakhstan do not receive support from their family members. One of the most important findings is that the majority of the participants shared that at least one family member was against their choice of STEM major. As one of the participants comments: 'When I entered the university, my father asked: 'why did you choose Electrical Engineering, you are a girl!' Another similar comment: 'Both of my parents were against my decision to enter the STEM major. They told that technical specialties are not meant for women, not for girls … ' Several participants noted that they heard negative comments about choosing STEM major from their relatives and extended family members. It should be also noted that extended family members are very important players in Kazakh traditional families. Sometimes some important decisions, such as to study abroad or in choosing the specialty is discussed in the family gathering which includes elder members of the family and other relatives. If the head of the family or elder member of the family does not support the girl's decision, it is usually not discussed further. As an old Kazakh saying says: 'A girl has prohibitions from 40 households.', which means that almost any relative can express his/her negative opinion in relation to a girl and her educational and occupational trajectory and the future and this opinion is normally accepted by girls.

School-related (mezo-level) factors

As it has become evident from the analysis, the school has a big impact on girls' decisions to pursue a STEM major. This section considers the findings of the study regarding the school-related factors, which include school culture, teachers, teaching style, peers and STEM-related development activities.

STEM – emphasis of the school culture

The strong Math-science component of curriculum in STEM-focused schools was cited as an important influence on female students' decision to enter a STEM major at university. We found that the participants from the STEM focused schools were more satisfied with their choice of major. The participants of the study from STEM–focused schools uniformly reported that their enriched curriculum and focus on STEM subjects as well as the availability of school clubs in STEM disciplines has influenced their decision to choose the STEM career pathway. Those participants also perceived themselves well prepared academically to perform well in Math-intensive university courses.

> We had more hours dedicated to Math and Science than any other school. Two hours of Math every day and we stayed for additional Math preparation after 6 o'clock … And at our schools we were often told that we study for the certain purpose and we should continue to develop our Math and Science skills and study further …

The STEM-focused culture of the school also frequently created a sense of competition between the students. The participants shared that the schools often held academic competitions in such subjects as Math and Science. Therefore, the students always strived to perform well and demonstrate their achievement to peers and this served as a facilitator of their further interest in STEM. One of participants who graduated from a highly selective STEM school commented:

> We had such a special atmosphere in our school … we used to have a competition between ourselves, a positive type of competition. I liked that in Math lessons someone will shout: 'I am first to solve this problem!' next time it would be another student to be the first and we had this competition in Math all the time.

Availability of STEM-related development activities

It was also identified that extracurricular activities related to STEM play an important role in future STEM career trajectory selection. Opportunities for participation in academic Olympiads in Math and Science, science project competitions and STEM university preparatory courses were cited by the participants as important factors of enrolling to a STEM major at university. Those participants who were involved in STEM Olympiads and science projects uniformly reported of developing the strong interest to the field and having greater clarity about the intention to choose the STEM major.

For those students who did not attend the STEM school, participation in extracurricular activities related to STEM was also a facilitator of their STEM interest. As one instance, a female participant comments:

> In 11th grade I attended the additional Math and Physics preparatory courses to get ready for the school final testing and I liked them so much that I decided to choose Physics as my major and then I switched to the electrical engineering major.

Teaching/peer influence

The participants agreed that the personality of their STEM subject teacher and the teaching style mattered a lot in influencing the decision to declare the STEM major at university. Many participants shared that their STEM teachers were very knowledgeable and passionate about their subject and demonstrated enthusiasm which was contagious to the students:

> … He [Physics teacher]was a young person … he gave us kind of interest in those natural sciences. Before that I was not that interested in Math and Physics, after his lectures I became more interested … I started to learn more … to do more self-learning and I guess that influenced my love in natural sciences … he was able to instill the love to Math, Physics, and other natural sciences …

> Our Physics teacher, she was really good … She explained the complex things so well, so broadly and interestingly. I was so fascinated with the subject that I knew already in the 7th grade that I will choose Physics as my major …

> I had a great Physics teacher … He was both a teacher and philosopher. We had 2 h of Physics, First, he explained the theory and then we had a tea with cookies and he told us wise stories and gave advices. I felt that I changed as a person after his lessons …

However, many students noted that there were subtle differences in the way encouragement was communicated to girls and boys. Some participants (24%) reported that although they enjoyed their STEM teachers' classes and displayed excellent academic performance, their teachers did not support their decision to enter a STEM specialty. Instead, they advised them not to choose the STEM career track. One girl remembered that her female Physics teacher, who was not married herself, advised them not to choose Physics as a major:

> She used to say: 'Do not choose Physics! There are two universities in any girl's life: to get higher education and to marry.' Then when we have chosen Physics, she was so upset: 'Why did you do that? Look, I have chosen Physics, I am 36 now and I am not married … '

Four other participants also shared their male STEM teachers advised them not to choose STEM subject as a major as they considered that STEM career track is not suitable for women and suggesting the female students those specialties, which were 'more suitable for girls.'

Quality of career guidance at school

Career guidance at school seem to be an important factor, which may influence the decision of girls to pursue the career. Many girls reported many doubts in the process of choosing their major and in the process of application to undergraduate studies, which could have been avoided if they experienced stronger support from the school. The girls reported critical periods, such as choice of subjects for Unified National Testing after grade 9, which determines the majors a student can apply at the university

and choosing the university major when they especially needed this guidance from their teachers and school administrators.

> 'The schools need to offer some courses, which can help the students to find their career interests. At grade 9 or 10 we are expected to choose the major and the core subjects, but at that time we really do not know who we want to become … The students need the help from psychologists who should help them to identify what they want to do in future … Starting from the 5th grade the students should be explained what particular skills and knowledge they need to have for certain specialty, so the students already know what they like and what they do not like … '

Several participants mentioned that they have been attracted by the university prestige and the scholarship opportunity, rather than major itself and they had very limited understanding what they specialty entails.

Contextual/cultural (macro-level) factors and influences

We have identified in the study that context and culture related factors and influences which might shape the girls' decisions to enrol to STEM majors.

Larger societal culture and gender role expectations

One of the key findings of the study is that context-related factors seem to have a great influence on choosing the STEM education track and further intention to pursue the career in STEM. It should be highlighted that in the majority of Kazakh households there is a strict division of labour. Men are considered to be the main breadwinners, women are caretakers:

> In our society, we have certain stereotypes. They should be changed … by some strong women. I always observe this around and in different talk-shows on TV: a strong message is communicated that men should work and women should take care of children. This is very specific for Kazakh families.

Household responsibilities are considered to be 'women's work' and it is very rare that man is helping his wife to wash the dishes or cook the dinner. Women play the primary role in housekeeping and caretaking, therefore from the young age girls are expected to help their mothers around the house. There exists a certain societal pressure on young girls to marry till particular age and to become a mother on time (getting married after 25 years is considered to be very late) and to play the primary role in child-caring and house-keeping. A Kazakh girl is expected to be modest, helping her mother with household responsibilities and serving male family members. As one of the participants comments:

> There are always such people around … who feel that they can comment on your personal life … like one of my aunts, when she sees me, she says: 'You need to get married next year!' Why? Because they think that no one will marry me after certain age, it is such a shame if I do not get married …

Another comment: 'They say a girl should marry before 25 and nobody cares that I haven't met a person whom I like … '

It is also important to highlight the son's role in family. First, it is vitally important for each Kazakh family to have at least one male child who 'will keep (continue) the bloodline' In many traditional households, from their childhood, the girls are made to think that their primary role is to become a good wife and a good mother and to prioritise the family. In the majority of families with children of both sexes, more attention in terms of education is paid to boys. The boys are given a priority to choose the specialty which will lead to a high salary. The families are more likely to pay for the tuition of their sons, whereas the girls are expected to win the scholarship, usually not in STEM-related field.

> I know many families where the son chose the specialty which he liked and the parents paid his tuition. As for daughters, they are pushed to go to any major which provides a scholarship. My family is not like this. I was allowed to choose a major myself. However, I felt the responsibility for this decision, I have two younger brothers and I knew that we do not have money to pay for education. Girls are always like this, they try not to put much burden on the parents and try to win a scholarship, no matter what major it is …

> It much easier [to decide about the major] for the boys … If they want something, they will get it. If they do not want to do something, they do not have to.

One would expect that in a context with strictly defined gender norms the parents do not encourage their daughters to pursue higher education. In Kazakhstan, contrary to this expectation, parents seem invest a lot in their daughters' education because the girls are expected to be well-bred and well-educated. However, the girls are not expected by their parents to choose the STEM career track as there exists a stereotype that STEM is a 'masculine profession', which 'is not suitable for girls.' Women are expected to work in the spheres, which, as people expect, 'do not pose a threat' to their family life. 40 percent of the participants mentioned hearing the comments that 'they will anyway stay at home' after the marriage no matter what kind of diploma and specialty they have. They were sometimes advised by their parents and surrounding people to choose the profession which, according to their perception, is 'more feminine' and 'more comfortable' for women's future husbands.

> The opinion of men matters … they think that these jobs are not for women, the women should not work at all or they should work in traditionally female fields and not even try to step into technical fields. These attitudes really throw the women back … this is why women leave the STEM occupations

Our study revealed that these conflicting societal expectations put much stress on young women. They definitely view themselves capable of performing well in Math-intensive majors, as they have been actually doing well at the school level. At the same time, the majority of interviewed participants continue to be influenced to various extent by conflicting societal expectations about their occupational track and start questioning whether they have made the right choice, which is very stressful for young women of their age.

Structure of the economy and labour market in the region

One of the factors affecting the girls' decisions to enrol to STEM postsecondary education seems to be related to existing economic and labour market differences in the regions of the country. We found a difference in the experiences of girls depending on the structure

of the economy in the region where they resided. In the highly industrialised Northern, Eastern regions of Kazakhstan women have greater employment opportunities than in the less industrialised southern region. There are many factories and plants in the North and South Kazakhstan and the population is more ethnically diverse. The majority of participants from these regions noted that it is more common that women work in the industry. Therefore they were often encouraged by their parents to enter STEM-related field. As one of the participants from East Kazakhstan comments:

> East Kazakhstan is very industrial … … we have such big enterprises as KAZZINC and KAZ Minerals in our region … Kazakhstan is very diverse … it is normal that girls study in technical majors here … and it depends o lot what parents advise

Western region presents an interesting case overall. The population in this region is historically more homogeneous with more citizen of titular ethnicity, who hold more traditional views on women and their occupations. However, due to recent discoveries of oil and gas in the Caspian Sea, the industry of the region is quickly developing and there is a lack of local specialists in STEM-related fields for the foreign companies working in the region. Five of six participants interviewed in that region reported that their parents supported their intention to choose the STEM educational trajectory as having a job in STEM and particularly in the oil industry is very important for the families' wellbeing. It seems that the population in the region is starting to become more liberal in their views on women's educational and occupational tracks.

> My parents themselves suggested that I should pursue a STEM major. You know, we live in Atyrau, which people also call 'the oil capital of Kazakhstan', therefore, it will be easier for me to find a job and earn a high salary if I major in oil and gas engineering

Regional cultural differentiation

One of the factors, which influenced the choice of a STEM major by a girl, was a specific regional culture and gender role expectations. In North and East, which are considered to be more liberal with respect to the rights of women, it was more acceptable for the girls to choose the STEM specialty. They felt more supported by their parents and family members in their choice of technical major and held more understanding of their future careers.

In less industrialised and more populated southern region, where the society is significantly influenced by traditional cultural norms the girls seem to face more stereotypes and attitudes toward STEM. The education of the daughter is in this region often considered to an investment to their successful marriage and a chance to get higher amount of *kalym* [a bride-price usually paid to the girls' parents by a groom to be]. Parents are often very proud of the education of their daughters, but encourage them to enter those fields, which are traditionally considered to be 'more feminine' so their future husband can allow them to work. Sometimes they might encourage their daughters to enter STEM field if there is a scholarship opportunity, as they see it more like a chance to get free higher education or transfer to a different major later on. This was the case for one of the participants, who came from South Kazakhstan to study in a technical university in North Kazakhstan:

> South Kazakhstan is very traditional and people try to keep cultural practices. For instance, a young married women should get up very early to do all the household responsibilities before

> going to work and she needs to wear a scarf. In North Kazakhstan, they do not follow these traditions … therefore I want to stay here [in North Kazakhstan] and find a job because there are less stereotypes and more opportunities for girls as the region is more industrial.
>
> In my home town [Kyzylorda, South Kazakhstan] it will be very difficult to find a job in mineral processing field.
>
> If a girl from our region decides to enter a STEM major, someone at some point, either a family member or a teacher, would certainly persuade her not to enter the STEM major.

In Central Kazakhstan, the situation is quite different from that in the other two regions. Seven participants, notably from the capital city, shared that their parents who hold more liberal views did not interfere with their educational decisions of what and where to study and supported them in the choice of their major. Young women from the region seemed to be more confident in their future, better positioned to ignore the restrictions from their elder family members and hold higher career aspirations.

Discussion

The aim of this study was twofold: to explore the experiences of female students in the Post-Soviet context during their transition to postsecondary education and the factors related to their decision to enrol into STEM majors. Many of this study's findings are consistent with what has been found in the studies conducted in other contexts and provide the supporting evidence of the interrelation of personal and environmental factors and behaviour as proposed by the SCCT (Lent et al., 1994, 2000). Our findings clearly show that girls in Kazakhstan wishing to pursue an education in STEM possess strong academic preparedness and content knowledge to achieve well in their fields. However, they sometimes display a lack of confidence while choosing their major, which according to the literature might cause low self-efficacy beliefs and, consequently, may influence their further interest in STEM, their persistence in higher education, as well as their career goals and actions. Parents and teachers, women role models, in particular, were found in the study to be especially influential in supporting and encouraging the school graduates for pursuing STEM majors at university.

The study demonstrated some interesting complexities, which are created in the Kazakhstani context by conflicting societal expectations about gender roles in the family life and gender norms in education and career. Although SCCT remains useful for understanding the process women's career choice in STEM, several gender theories, such as Gender Role theory and Gender Socialisation Theory seems to be more powerful in explaining the challenges faced by female students in the process of choosing STEM educational trajectory.

Consistently with the predictions of Gender Role Theory (Eagly, 1987), girls in Kazakhstan are greatly affected by the legacy of the sexual division of labour the gender role expectations, which support the division (Kuzhabekova et al., 2018; Kuzhabekova & Almukhambetova, 2019). According to these expectations, the girls need to be well-educated and always display high academic performance. However, when it comes to choosing the major, they are not expected to choose 'masculine' STEM major as there is a perception that women cannot perform well in traditionally male-dominated areas and

are unable to combine 'a masculine profession' and family responsibilities in future. It was identified that these conflicting societal expectations confuse the young women wishing to pursue their education in STEM. On the one hand, they feel capable to achieve as much as their male peers. On the other hand, they receive the messages from the society and surrounding people that technical fields are the men's realm and start to question their abilities and future doubting that they will be able to work in highly demanding STEM field. As the Gender role theory posits, as a result of such gender role orientation, girls can become less ambitious in comparison with boys and will not aspire for successful career, will display lower motivation and lower self-esteem in comparison with men (Caceres-Rodriguez, 2013).

Consistently with the Gendered Socialisation theory, young men and women are socialised differently in family and education context in Kazakhstan. From their childhood, young women are bombarded with stereotypes regarding their abilities to succeed in Math and other STEM subjects and stereotypes that STEM is a male field. These stereotypes and mentalities are communicated to females from young age, mostly subconsciously through surrounding people, teachers, parents (Gunderson et al., 2011). The study shows that these gendered stereotypes and negative comments gradually lessen girls' interest in STEM, steer them away from choosing to enter the STEM majors and undermine their sense of belonging to profession. The study identified that the girls with higher confidence and support of family, particularly male members of the family, are able to overcome the stereotypes associated with their gender. Consistently with gender socialisation theory, parents were found to be influencing the young girls' interest in STEM by advice, personal example and exposure to variety of educational and everyday experiences and activities.

We also found that there exists regional differentiation in culture, which is also related to labour market and economic conditions. Local labour market conditions, including the location of industry as well as the cultural beliefs about professional and family roles of males and females typical for a region, were found to be influencing the process of female students' choice of major. The prospect to earn higher salaries in the regions, where the industry is well-developed, makes families accept more neoliberal views on career prospects of their daughters, whereas in more traditional and non-industrial southern region the enrolment of girls to STEM majors is more problematic. In capital cities, where the families are more likely to hold liberal views and where parents are well-educated, girls feel more confident to choose STEM major.

The findings from this study contribute to the existing scholarship in at least two major ways. First, unlike previous research on this topic, which mostly has sought to identify the institutional factors, the study highlights the influence of contextual/cultural factors on girls' self-efficacy beliefs in the process of career choice and highlights the interrelation of school and family and context-related factors. Second, the findings provide evidence that in any traditional society with clearly defined gender roles, notwithstanding the seemingly high levels of gender parity in official statistics, traditional beliefs and genders norms exert significant influence on girls aspiring to pursue education in STEM. Therefore, these beliefs and norms should be taken into consideration while implementing policies to improve the state of gender equality in male-dominated fields.

Conclusion and implications

The findings from this study suggest certain implications for practice. Although the majority of challenges faced by girls seem to be impacted by wider sociocultural influences and labour market and regional differences, there are certain things that schools can do to address the issue of underrepresentation of women in STEM fields. Our work suggests the need for institutional policies at secondary school levels necessary to support young girls in the process of choosing the major, providing gender-responsive career counselling and mentoring opportunities, stimulating the interest to STEM- related subjects. The school administration needs to ensure that the teachers are trained in using gender-responsive advising and instructional strategies, and that more education is provided to parents and family members to ensure that they encourage and support girls to choose STEM majors. It seems that the importance of parental and teacher encouragement for the girls intending to choose the STEM major is underestimated in the Kazakhstani school context.

The study pointed out to vulnerability of female students to gender-related stereotypes, therefore it is important to implement some measures to combat these stereotypes. Due to the absence of images of successful women working in STEM communicated in the mass media and throughout the school curriculum, young women fail to develop a proper understanding of a woman's opportunities in STEM fields, which can help their professional choices when they finish their studies. Therefore, more attention should be paid to the promotion of images of successful women working in STEM, so that they serve as role models for girls intending to pursue education and career in STEM. Increased exposure to women role models can potentially help to overcome the stereotypes associated with STEM (Hill et al., 2010).

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