

**Gender Differences in Grade 12 Students' Engagement in STEM Subjects:
A Case Study of One Specialized School in South Kazakhstan**

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GENDER DIFFERENCES IN STUDENT ENGAGEMENT

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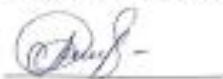
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20 November 2019

Dear Akmaral Dauletiyarova

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You may proceed with contacting your preferred research site and commencing your participant recruitment strategy.

Yours sincerely

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Abstract

School engagement is considered vital for students' motivation and their academic performance. However, a significant decline in student engagement has been observed in most countries across the globe, especially in the field of STEM (Science, Technology, Engineering, and Mathematics). Several empirical studies suggest numerous individual and contextual factors, influencing student engagement in STEM, with gender and age being the most significant issues affecting school engagement (Martin, 2007; Nako, 2015). Therefore, it is crucial to investigate how student engagement is gendered because a deeper understanding of this would help identify ways of mitigating student alienation and dissatisfaction with school in general and STEM in particular, since women are underrepresented in STEM occupations around the world. This qualitative study explores the ways gender differences are played out in school engagement in STEM subjects in Kazakhstan. Since enhancing women's participation in STEM is a policy priority in Kazakhstan, identifying what supports the engagement of girls and boys in STEM and what weakens it could potentially identify strategies at different levels and for different actors to enhance the recruitment of both men and women in STEM subjects. First, the study examines the concept and nature of school engagement. Second, the study explores gender disparities in student engagement. Two focus group discussions with Year 12 students of one specialized school were conducted using a purposeful sampling method to examine the specified issues in depth. The findings revealed that student engagement in STEM is not a fixed, but a fluid state that varies depending on several factors including gender. Certain student norms of behavior, including solving problems and adhering to classroom rules were found highly gendered. Societal norms on gender, gendered classroom norms, and the future utility of STEM can explain gender differences in student engagement. The findings also indicate that applying practical work,

solving problems, group work and having competitions might enhance the engagement of both girls and boys in STEM subjects.

Key words: student engagement, STEM, gendered academic disciplines, gendered norms, teacher exposition, Kazakhstan.

Тақырыбы: «12-сынып оқушыларының STEM пәндеріне қатысуындағы гендерлік айырмашылықтар: Оңтүстік Қазақстандағы бір арнайы мектептегі зерттеу»

Аңдатпа

Оқушылардың мектепке қатысуы оқушылардың ынтасының артуы мен оқу үлгерімінің жақсаруы үшін өте маңызды болып саналады. Алайда, әлемнің көптеген елдерінде оқушылардың, әсіресе STEM (Ғылым, Технология, Инженерия және Математика) сабақтарындағы белсенділігінің едәуір төмендеуі байқалды. Бірнеше эмпирикалық зерттеулер STEM-дегі оқушылардың белсенділігіне әсер ететін көптеген жеке және контекстік факторларды айқындады, олардың ішінде оқушылардың жынысы мен жасы мектеп белсенділігіне әсер ететін маңызды факторлар болып табылады (Martin, 2007; Nako, 2015). Сол себепті, STEM сабақтарына қатысуындағы оқушылардың жынысының рөлін анықтау маңызды. Бұл аспектіні тереңінен түсіну оқушылардың мектептен тысқары қалуы және мектепке деген жағымсыз көзқарасты жақсартудың жолдарын анықтауға көмектеседі, өйткені әлемде STEM саласында әйелдер аз қамтылған. Бұл сапалық зерттеу гендерлік айырмашылықтардың STEM пәндеріне қатысуда қалай көрінетіндігін қарастырады. Біріншіден, бұл жұмыс мектепке қатысу түсінігі мен оның мәнін зерттейді. Екіншіден, зерттеу оқушылардың STEM сабақтарына қатысуындағы гендерлік айырмашылықтарды зерттейді. Осы мәселені терең зерттеу үшін мақсатты іріктеу әдісін қолдана отырып, дарынды балаларға арналған мектептің 12-сынып оқушыларымен екі фокус топтағы талқылау өткізілді. Зерттеу нәтижесінде оқушылардың STEM-ге қатысуы өзгермелі құбылыс екендігі анықталды, ол бірнеше себептерге, оның ішінде оқушылардың жынысына байланысты да өзгереді.

Оқушылардың белгілі бір мінез-құлық нормаларында, оның ішінде мәселелерді шешуі және сынып ережелерін сақтауында гендерлік айырмашылықтар айқындалды. Гендер бойынша әлеуметтік нормалар, сыныптағы гендерлік нормалар және STEM-нің

болашақтағы пайдасы туралы студенттердің көзқарасы STEM сабақтарындағы гендерлік айырмашылықтардың себептері болуы мүмкін. Зерттеу нәтижелері сабақта практикалық жұмысты көбірек қолдану, проблемаларды шешу бағытталған тапсырмалар, топтық жұмыс және жарыстар өткізу STEM пәндеріне деген қыздар мен ұлдардың белсенділігін арттыра алатындығын көрсетті. STEM-ге қыздардың қатысуын арттыру Қазақстанда маңызды болғандықтан, оқушылардың сабаққа қатысуын қолдайтын және әлсірететін факторларды айқындау әр түрлі деңгейде STEM саласына ерлер мен әйелдерді тартудың тиімді стратегияларын анықтай алады.

Түйін сөздер: оқушылардың белсенділігі, STEM, гендерлік оқу пәндері, гендерлік нормалар, мұғалімнің сабақ түсіндіруі, Қазақстан.

Тема: «Гендерные различия в вовлеченности учащихся 12 классов в предметы STEM: пример одной специализированной школы в Южном Казахстане»

Аннотация

Участие в школе считается очень важным для мотивации учащихся и их успеваемости. Тем не менее, в большинстве стран мира наблюдается значительное снижение вовлеченности студентов, особенно в области STEM (наука, технология, инженерия и математика). Несколько эмпирических исследований предлагают многочисленные индивидуальные и контекстуальные факторы, влияющие на вовлечение учащихся в STEM, при этом пол и возраст являются наиболее значимыми факторами, влияющими на школьную активность (Martin, 2007; Nako, 2015). Следовательно, крайне важно исследовать вовлеченность учащихся, поскольку более глубокое понимание этого поможет определить стратегии, которые помогут обеспечить активное участие в школе и STEM в частности, поскольку во всем мире мало женщин в профессиях STEM. Это качественное исследование исследует, как проявляются гендерные различия в школьной вовлеченности в предметы STEM. Во-первых, данная работа исследует концепцию и особенности участия в школе. Во-вторых, исследование исследует гендерные различия в вовлеченности студентов. Две дискуссии в фокус группах с учащимися 12-го класса одной специализированной школы проводились с использованием целенаправленного метода выборки для углубленного изучения указанной проблемы. Результаты показали, что участие студентов в STEM является не фиксированным, а текучим состоянием, которое варьируется в зависимости от нескольких причин, включая пол. Определенные студенческие нормы поведения, включая решение проблем и соблюдение правил в классе, были сочтены высоко гендерными. Социальные нормы в отношении пола, гендерные нормы в классе и понимание пользы STEM в будущей профессии могут объяснить гендерные различия в

вовлеченности студентов. Результаты также показывают, что применение практической работы, решение проблем, групповая работы и проведение соревнований могут повысить вовлеченность как девочек, так и мальчиков в предметы STEM. Поскольку рост участия женщин в STEM является значительным в Казахстане, определение того, что способствует вовлечению девочек и мальчиков в STEM, и что ослабляет его, потенциально может определить стратегии на разных уровнях и для разных участников, чтобы повысить вовлеченность как мужчин, так и женщин в предметы STEM.

Ключевые слова: вовлеченность студентов, STEM, гендерные учебные дисциплины, гендерные нормы, экспозиция учителя, Казахстан.

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Chapter 1: Introduction

School engagement of students is one of the most influential factors that affect the construction of student identity (Carvalho et al., 2015), contributes to student learning (Fredricks, Filsecker, & Lawson, 2016) and predicts students' learning trajectory (Kuh, as cited in Sharma & Garg, 2015). In the last ten years, the interest in school engagement has increased globally due to reasons related with history, economy and practice (Fredricks, Blumenfeld, & Paris, 2004). History professors, Modell and Elder (2002) wrote about the decrease in students' respect for educational institutions and teachers, since students describe learning at schools as a boring process and they do not put much effort on acquiring knowledge. Scholars are concerned because with such an attitude to schooling, students will not obtain the capabilities and skills that are necessary to meet the demands of the job market (Fredricks et al., 2004). Moreover, lower level of engagement is the biggest problem that many teachers confront in their classrooms (Fredricks et al., 2016). Therefore, it is important to find out the most significant factors that are closely related to this issue in order to successfully engage students in schools.

The study focuses on how gender shapes school engagement because along with age, it is one of the two major factors reported to have a stronger impact over school engagement (Martin, 2007; Nako, 2015). That is why it is crucial to investigate how student engagement in the classroom is gendered, as not understanding this properly may lead to student alienation and dissatisfaction towards the school in general (Nako, 2015). A plethora of studies on the relationship between student engagement and gender have found that female students are more engaged than male students, especially in the field of languages (e.g. Amir, Saleha, Jelas, Ahmad, & Hutkemri, 2014; Johnson, Crosnoe, & Elder, 2001; King, 2016; Lietaert, Roorda, Laevers, Verschueren, & De Fraine, 2015). Although girls engage more than boys, when it comes to STEM, their engagement drops relative to boys (Martinez & Guzman, 2013;

Stoet & Geary, 2018). In addition, official discourses consider STEM an area that is vital to individual and national progress and prosperity in the modern “knowledge economy” (Mendick, 2013, p. 202), which has become largely a male-dominated field (Martinez & Guzman, 2013). Therefore, it is necessary to understand what makes STEM a masculine subject and what prevents the subject from being compatible with femininity.

Statement of the problem

Despite some policy changes in secondary education, such as the curriculum update, a new criteria-based assessment model and the use of student-centered learning to ensure students’ classroom engagement directed at improving students’ academic performance, little has changed in student involvement because it is still a serious issue in Kazakhstan (Kabulova, Pussurmanova, Shaikhina, Akhmedina, & Issina, 2016). The authors state that in many Kazakhstani schools, students do not demonstrate interest in learning, which leads to “low academic performance and motivation loss” (p. 15). For many years, encouraging student participation in the classroom has been seen as the responsibility of teachers only, and the primary reason for the low motivation and involvement of students has been considered insufficient or poor qualifications of teachers, which teachers themselves indicated as one of the main reasons for this issue (OECD, 2014). However, the impact of other factors on school engagement, such as gender, and students’ perspective on engagement have not been fully investigated in the country.

Furthermore, the results of international assessments PISA (Programme for International Student Assessment) and TIMSS (Trends in International Mathematics and Science Study) indicate that Kazakhstan’s performance in natural sciences is less than desirable. Kazakhstani students have far much lower scores in mathematical and scientific competence compared to top performing countries in the international study TIMSS (IAC, 2015). In PISA, nearly all Kazakhstani participants are not able to complete the most difficult

tasks of the test on mathematics and science, suggesting that every third participant is functionally illiterate (IAC, 2017). Exploration of student engagement in STEM may help identify strategies of sustaining and promoting student engagement that could potentially enhance student performance in STEM subjects.

Gender stereotypes such as considering the role of women as related to housework and family have been found during a gender assessment study in Kazakhstan by the Asian Development Bank [ADB] (2018). This suggests the presence of gendered career choices at the tertiary level, especially in STEM because it is seen as a male-dominated area. That is why the current study examines different perspectives on gender disparities in student engagement at STEM subjects of Grade 12 students in depth because student engagement especially in the high school will have greater implications in the choice of students' future profession.

Purpose of the Study

The purpose of the study is to explore the ways gender differences are played out in school engagement of Year 12 students in STEM subjects.

Research Questions

This study is focused on exploring the gendered nature of student engagement in STEM, and aims to answer three research questions:

1. In what ways does student engagement in STEM differ between boys and girls?
2. What reasons can explain gender differences in student engagement in STEM if they emerge?
3. What strategies might enhance the engagement of students, both girls and boys, in STEM?

Significance of the Study

It is important to investigate gendered experience of students in STEM subjects, as this academic discipline is highly gendered, with a lower female participation rate. Therefore, the study is significant to identify the reasons for gender differences in STEM in high school, because at this level, students start actively making up their mind or are already certain about their future careers.

Moreover, understanding the role of gender in student engagement will provide new insights to teachers about how to select and organize educational activities that will involve all students in the class. Thus, all learners will be given equal opportunities to study, and, as a result, students' academic achievements may improve.

More importantly, the results of this study can contribute to designing and delivering gender-responsive career counselling, and equally recruit men and women in STEM areas. This can also raise parental awareness on career guidance and provide practical support to families, as they are also significant actors in their children's career choices.

In addition, the study is significant from a policy perspective. The participation of females in STEM at university is a high priority of the Government of Kazakhstan, since women are concentrated predominantly in medicine and men in engineering (UNESCO Bangkok, 2016). Thus, identifying what supports the engagement of girls and boys in STEM and what weakens it could potentially identify strategies at different levels and for different actors to enhance the recruitment of men and particularly women in STEM subjects.

Finally, since the research on the gendered nature of student engagement in STEM in Kazakhstan is very scarce, the study will fill an important gap in the literature.

Definition of the central phenomenon

The central phenomenon of this study is Grade 12 students' gendered experiences in STEM subjects in one school for gifted children in south Kazakhstan. However, prior to investigating the role of the central phenomenon in school engagement, it is crucial to

understand the notion of student engagement. Chapman (2003) characterized school engagement as the eagerness of students to take part in classroom activities, complete assignments and follow teachers' classroom instructions, whereas Skinner and Belmont (1993) defined the specified term as behaving positively and showing positive emotions in the learning process. Finn (1993) describes the model of school engagement as "having a behavioral component termed *participation* and a psychological component termed *identification*" (p. 6). Student engagement in this study is understood as active participation in the classroom, asking and answering questions, as well as completing assignments.

Gender is another central construct in my study. West and Zimmerman (1987) defined gender as performance, while Ridgeway and Smith-Lovin (1999) described the term as a "system of social practices within society that constitutes people as different in socially significant ways" as the result of interaction (p. 247). Likewise, Subbo (2002) argues that gender, as a social construct, is related to social and cultural norms, morality and expectations, where the "expectations and responsibilities of men and women are not always biologically determined" (p. 1). This study also views gender as the behavior we demonstrate, rather than the biological attributes of men and women.

Outline of the Study

This chapter described the rationale for the research problem, described the purpose and significance of the study, presented the research questions and identified the central phenomena of the study. The second chapter presents the review of literature on the topic and theoretical framework that guides the study. The third chapter explains the methodology used in the study, while the fourth chapter presents the analysis of findings. The fifth chapter discusses the findings of the study in relation to existing literature on the topic. The last chapter summarizes the study and presents recommendations and implications for further research.

Chapter 2: Literature Review

This study explores gender differences in year 12 students' engagement in STEM subjects. In this chapter, I review and synthesize existing studies regarding students' gendered experiences in STEM (Science, Technology, Engineering, and Mathematics) subjects.

The chapter is organized into five sections. The first section presents the theoretical framework that guides this study, while the concepts of *engagement* and *gender* are defined in the second section of the chapter. The third section examines the factors that affect student engagement. The fourth and fifth sections focus on the role of gender in student engagement and on the specific features of STEM subjects respectively. I argue that identifying what supports and what weakens the engagement of girls and boys in STEM could potentially identify strategies at different levels and for different actors to enhance the recruitment of men and particularly women in STEM subjects.

In recent years, while globally the demand for STEM qualified professionals has increased, a decline in student engagement in those subjects has been observed, with substantial research evidence indicating that disengagement from STEM subjects starts during secondary education (Timms, Moyle, Weldon, & Mitchell, 2018). The authors identified a range of factors that both hinder and support school students' engagement in STEM, and if student engagement in STEM is low at the secondary level, they are likely to discontinue studying STEM after compulsory education (p. 347). Therefore, it is important to identify the ways to promote student engagement, since the problem of low student engagement in the classroom is a serious issue in Kazakhstan too (Kabulova et al., 2016).

Theoretical Framework

A theoretical framework “refers to the specific perspective that a researcher chooses to explore, interpret and explain events, and shed some light on a particular phenomenon or research problem” (Imenda, 2014, p. 189). Theoretically, my research is informed by post-

structuralism, which identifies theories about the relationships between people and their practice, and rejects the existence of absolute truth about the world (Belsey, 2013). I believe that those relations describe different aspects of social reality and help us recognize and make sense of the construction of reality (that is, how school engagement differs by gender in STEM subjects in the current study), not reality itself.

The literature suggests that post-structuralists should be able to use different, sometimes conflicting points of view, to create a comprehensive explanation of the issue and find the meanings of social reality (Harcourt, 2007). My post-structuralist orientations imply that my reading and review of the literature seek to understand student engagement in STEM as social practice using different perspectives on the topic.

Defining engagement and gender

Research related to the concept of student engagement has grown over the past years. Notwithstanding the agreement on its relevance, the conceptualizations of student engagement vary across studies.

Engagement, as a multidimensional concept, is related to behaviors and attitudes (Glanville & Wildhagen, 2007). According to Sharma and Garg (2015), “student engagement refers to the time and energy students invest in educationally purposeful activities” (p. 1). However, they remind that it is more than just participation because it involves understanding, feelings and activity. Chapman (2003) defined school engagement as students’ positive disposition to participate in classroom activities, complete tasks, and adhere to classroom instructions, while Tomlinson (as cited in Conner, 2011) conceptualized engagement as an incentive that attracts students’ attention, which implies that they grasp how an important idea works, that is, the student owns their learning.

Literature defines three components of engagement: emotional, behavioral and cognitive, where behavioral engagement refers to “students’ participation in academic and

extracurricular activities” (Fredricks et al., 2004, p. 60). It incorporates classroom attendance, obeying school rules and regulations, higher level behaviors like students’ effort and determination to learn (Glanville & Wildhagen, 2007). Emotional or affective engagement is “concerned with students’ affective reactions (anxiety, happiness and enjoyment) to school and school activities” (Skinner, Kindermann, Connel, & Wellborn 2009, p. 227). It emphasizes the degree of positive and/or negative responses to school, classmates and teachers, and a sense of belonging to school (Fredricks et al., 2016), while cognitive engagement is associated with self-management, strategic learning, profound understanding and attaining thinking skills (Fredricks et al., 2004, p. 60).

Gender is another central construct in my study. Subbo (2002) defined gender as a social concept that is linked to social and cultural norms, whereas Mendick (2016) identified gender not as a fact or something that we are born with or possess, but as “something that we do” and as the result of performing repeated acts that relays our gender within social regulations (p. 2). Discourses that explore gender performances and relations in the classroom emphasize how boys and girls position themselves differently and that they are positioned differently as *learners* inside the classroom, with girls being marginalized regardless of their academic successes, both by peers and teachers (Renold, 2006). Taking a post-structuralist position, I believe that gender identity is created by the performances we put on and the behaviors we demonstrate, not merely by the biology of our bodies. My view of gender is that there are no fundamental differences between the ways girls and boys engage with STEM that can be linked to their biological differences. It is the gender norms which are socially constructed that regulate our practice and behaviors including our engagement in STEM.

Factors influencing student engagement

In order to successfully engage students in schools, it is important to find out the factors that are closely related to this issue, since engagement is not an attribute of teachers or

students, but a facet of a bulk of influencing factors, such as policies, age, gender, family and peers (Sharma & Garg, 2015).

Numerous individual and contextual factors affect students' school engagement. The personal factors influencing student engagement include year level, gender, socio-economic status and others, while the contextual factors consist of the components of the learning environment – peer relationships, teacher-student relationship, school climate, educational experiences and family support (DeVito, 2016; Nako, 2015). However, gender is one of the two features, along with age, that has a stronger impact over school engagement (Martin, 2007; Nako, 2015). Therefore, it is crucial to investigate how student engagement is gendered because a deeper understanding of this would help identify ways of mitigating student alienation and disaffection towards the school in general and STEM in particular.

Gender and student engagement

I first look at student engagement broadly before focusing on student engagement in STEM. Much of the literature shows significant differences in school engagement based on gender (Hughes, 2015; Martin, 2007).

A study of students' personal accomplishments by Diseth and Samdal (2015) in Norway revealed some signs of small general gender differences, according to which females expressed higher aspirations than male learners. Similarly, research conducted in Malaysia by King (2016), and in the Philippines by Lietaert et al. (2015) highlight the significance of gender in students' classroom engagement, stating that girls are more engaged than boys, particularly in the field of languages. Likewise, Amir et al.'s (2014) study in Malaysia showed that female students show a higher level of engagement in learning and school activities compared to male students. Martin (2007) and Johnson et al. (2001) also argue that female students are more likely to have a higher level of emotional, behavioral, and cognitive engagement, as they were found to manage their studies better and value school work more

than boys. Male students tend to have a more negative attitude towards school and schoolwork than females (Horne, 2000).

However, numerous studies on student engagement in STEM subjects depict a different picture. For example, a number of studies carried out in the UK and USA show that in STEM subjects, male students are more engaged than their female counterparts (Martinez & Guzman, 2013; Stoet & Geary, 2018), suggesting that although girls engage more than boys, when it comes to STEM, their engagement drops relative to boys. According to the results of the survey conducted by the US Census Bureau (Landivar, 2013), there is a substantial gap in the engineering and computer sectors, which contributes to the overall underrepresentation of women in STEM. In 2015, women in the US represented less than a quarter (24%) of employees in STEM (Noonan, 2017). The UK and US contexts have dominant discourses that position engagement in STEM as a masculine enactment. The report by the US Department of Commerce (Beede et al., 2011) argues that men are much more likely than women to get jobs in STEM fields, regardless of educational achievement, suggesting that “strong gender stereotypes discourage women from pursuing STEM education and STEM jobs” (p. 8). There is also a recognized social phenomenon of “male dominance and female submissiveness” in the US that “advances men in fields related to STEM while discouraging or leaving women behind” (Reinking & Martin, 2018, pp. 148-149).

Moreover, in the UK, the percentage of students choosing the combination mathematics, physics, and chemistry fell significantly by 45% between 2001 and 2003, and 25% of universities in the UK closed departments in the STEM subjects (Roberts, 2002). Although they make up about half of the workforce, the share of women working in STEM areas comprises only 14,4% in the UK (Gjersoe, 2018). According to Hanna (as cited in Mendick, 2005a), *mathematical ability*, as a natural, individual and masculine feature, makes it more problematic for females to identify themselves and be identified by others as *good at*

maths, and this can be used to understand the outflow of females from mathematical fields of academia and employment internationally. In her paper “A Beautiful Myth? The Gendering of Being/ Doing ‘good at maths’”, Mendick (2005a) asserts, “discourses are gendered; they inscribe mathematics as masculine, and so it is more difficult for girls and women to feel talented at and comfortable with mathematics and so to choose it and to do well at it” (p. 217). In the UK, despite the introduction of different policy interventions, and small differences in GCSE-level, AS-level, or A-level mathematics grades between boys and girls, the decision to continue with advanced mathematics remains mainly gendered (Mendick, 2005b; Mendick, 2013). Cheryan, Ziegler, Montoya and Jiang (2017) also found large gender differences in the participation across STEM fields, particularly, in computer science, engineering, and physics than in biology, chemistry, and mathematics, with women being a minority.

Several studies identified social norms about gender as a barrier for women to choose STEM. A study in Turkey by Özkale, Küskü and Sağlamer (2004) found that gender-based discrimination in the workplace and traditional views about what is male and female appropriate in society can explain the low concentration of females in engineering. Similarly, the Asian Development Bank (2018) has determined that the presence of gender stereotypes in Kazakhstan, which associate the role of women with housework and family, might prevent women from choosing a career in STEM. Therefore, it is important to see what happens in STEM that is of a particular concern for female students’ engagement.

Specific features of STEM subjects

There are different views among academics about the involvement of boys and girls in STEM – the area that is vital for individual and national progress and prosperity in the contemporary “knowledge economy” (Mendick, 2013, p. 202). Numerous research studies have focused on gender effects in STEM subjects, with a comparatively small number of girls choosing mathematics and subjects in the natural sciences (Bennett, Braund, & Sharpe, 2013).

It was found that female students feel far less confident in their self-efficacy in STEM: 33% compared to 60% of males; therefore, their perception of and attitude towards STEM is less positive than that of their male counterparts (Brown, Brown, & Bibby, 2007; Department of Education, 2019; Nardi & Steward, 2003). Although numerous discourses claim about the underrepresentation of women in STEM, PISA-2012 results for Kazakhstan indicated that girls scored 9 points higher in science than that of boys, resulting in higher overall grades of 1.43 points (UNESCO Bangkok, 2016). The enrolment in STEM-related programs at the tertiary level in Kazakhstan also depicted a higher percentage (66.3%) of females, however, most of female students were concentrated in disciplines widely perceived as science-based STEM fields (biology, chemistry, and medicine), rather than in disciplines perceived as math-based STEM fields, that is, physics and engineering, suggesting that engagement with STEM is gendered in Kazakhstan (p. 2).

Enhancing student engagement, especially in the area of STEM, where females are still underrepresented, has become a priority of educational policies also in many European countries (Lucena & Schneider, 2008). Discourses highlight that female students consider STEM to be a difficult problem (Mendick, 2005a), and that STEM has become largely a male-engaged area (Martinez & Guzman, 2013; Stoet & Geary, 2018). Key features of such distinction lie in the “sameness/ differences between mathematics and *other* subjects, between mathematicians and *other* people”, and in how learners are defined in a range of opposing binary positions like “maths people/ non-maths people, maths and sciences/languages and arts”, where higher significance is linked with masculinity, and poor value with femininity (Mendick, 2005a, p. 212). For instance, Mendick (2005a) argues that the truth about *being good at maths* is often stereotyped in favor of men because of the widespread perception of masculine features of STEM, and the fear of being wrong and irrational among women. Zhu (2007) also highlighted the presence of stereotypical views on men’s and women’s

mathematical and science abilities, differentiated expectations and encouragement of males and females, using the term “*gender stereotype threat*” (p. 197). Despite high educational achievements of women in international tests PISA and TIMSS, Kazakhstani society also views STEM as a masculine area (Almukhambetova & Kuzhabekova, 2020). Chan and Cheung (2018) also support this position, arguing that gender stereotypical beliefs in STEM can lower girls’ confidence and evaluation of their academic achievement that results in abandoning the STEM pursuits, despite great efforts at school. Scholars argue that there are implicit societal gender norms on which career choices are appropriate for boys or girls that view STEM as a superior subject area not appropriate for women (Belmonte, 2012; Dom & Gihong, 2018; Ozkale, Kusku, & Saglam, 2004; Van der Vleuten, Jaspersa, Maasa, & Van der Lippea, 2016). Therefore, STEM classrooms should be organized in the way that each individual can fulfil their potential, as student identity is critical in ascertaining specific features of STEM subjects, and in predicting students’ decision to choose STEM as a career (Godwin et al., as cited in Berge, Silfver, & Danielsson, 2019). Discourses related to career choice are very gendered in the context of Kazakhstan, since there are different “societal culture and gender role expectations” for males and females, which are reflected in women’s decisions not to choose STEM as a career, but to opt for less masculine areas despite their interests and equal achievements with men (Almukhambetova & Kuzhabekova, 2020, p. 13).

Another example of the significance of student identity is evidenced by Ottemo’s (2015) study conducted in Sweden, which reported on students displaying different learner identities, with computer science being associated with masculinity and the position of geek, and with chemical engineering students identifying themselves as hardworking. A clear gendered pattern was observed in the study by Du (2006) at a Danish university, according to which complex STEM subjects were more preferred by men “due to their passion for tinkering, experience of machinery, and a suitable gender role to undertake engineering as a

future occupation” (p. 37). Moreover, STEM professions were seen as a barrier for women, since they did not “have a clear determination to become engineers” from early ages (p. 38). In addition, female engineering students in Lebanon expressed that “strong opposition from the family and friends of the family, compromises between family and career, and the feeling of marginalization in the masculine culture of engineering” can hinder the choice of STEM by women (Mozahem, Ghanem, Hamieh, & Shoujaa, 2019, pp. 130-131). Similarly, boys and girls in Kazakhstan are exposed to the socially instilled conception of male and female appropriate careers from a young age, which views STEM as not suitable for girls (Almukhambetova & Kuzhabekova, 2020).

Studies also report that gender is at play when it comes to who is encouraged to study STEM by significant actors, such as teachers, family members and friends (Bennett et al., 2013). For example, Mujtaba and Reiss (2014) argue that female students are less likely to be supported to study physics as a subject of choice in high school by significant actors in contrast to boys who are highly encouraged to aspire towards a career in STEM areas. In Kazakhstan, parents and teachers usually discourage female students from choosing STEM careers, which in turn leads to gendered student engagement in STEM (UNESCO Bangkok, 2016). In general, teachers tend to perceive girls’ high attainments as the result of their hard work, while linking boys’ educational achievements to their inherent abilities (Maynard, 2002). Moreover, teachers tend to interact with boys more than with girls, and give more opportunities to boys to show their STEM competence and skills in the classroom (Jones & Dindia, 2004; Li, 1999). Although teachers encourage male students to pursue STEM careers more, they expect girls to work hard, do homework and follow classroom rules (Renold, 2006). Similarly, Sunderland’s (2004) study in Australia found that teachers seem to ask boys more challenging questions, giving them more opportunities to show their skills, but they still set higher expectations for girls on how to produce work, which can diminish female

students' interest in STEM. Several studies found that female students spend more time and effort on assignments, and produce more accurate and detailed work than their male counterparts (Xu, 2006; Younger & Warrington, 1996). This might highlight the importance of teachers' role in STEM subjects to improve the engagement of both boys and girls (Reilly, Neumann, & Andrews, 2015). Internal motivation to study STEM and a more positive view of teachers and classroom may distinguish the small proportion of women who plan to study STEM as a career from those who have no intention to learn it beyond the compulsory period (Bennett et al., 2013).

Given gender differences, several strategies have been proposed to promote the involvement of both male and female students in STEM. Watt (2016) suggests that a "mastery learning environment" focused on understanding and mastering STEM contributes to students' self-improvement and influences their values and future career aspirations of women more than an achievement-based learning environment that focuses on performance and results (p. 42). In addition, along with providing early STEM experiences in the classroom and in extracurricular activities, having STEM teachers in schools and successful women in STEM fields as role models can encourage female learners to better embrace the value of STEM and choose it as a career (Cheryan et al., 2017). Scholars recommend organizing more STEM courses and hands on practice for female students to learn more about different opportunities in STEM fields (Burkam, Lee, & Smerdon, 1997; Oakes, 1990; Skelton, Francis, & Smulyan, 2006). Furthermore, numerous research has noted the benefits of collaborative strategies for girls, arguing that work in small groups helps create an equitable learning environment for girls in STEM and has a positive impact on their persistence in STEM disciplines (Oakes, 1990; Raes, Schellens & De Weber 2014).

Overall, scholars suggest that women are more engaged in the classroom than men (e.g. Amir et al., 2014; King, 2016; Lietaert et al., 2015), but when it comes to STEM

subjects, male learners appear to demonstrate a higher level of engagement (Martinez & Guzman, 2013; Stoet & Geary, 2018). Gender stereotypes that view STEM as a masculine field seem to affect female students' decisions about their future careers and might explain the low concentration of women in the STEM pipeline. Therefore, different studies suggest a wide range of strategies to enhance women's engagement in STEM. Such strategies include choosing resonate examples with both boys and girls, using female role models in the classroom, changing teaching and learning environments, encourage participation in-school and out-of-school programs, and provide internships for female students to learn more about different possibilities in the STEM fields (Purcell, 2015; Skelton et al., 2006).

The next chapter will explain the research design, sampling and data collection tool used in the study. Procedures for recruiting participants, data analysis, ethical considerations and limitations of the study will also be described in the following chapter.

Chapter 3: Methodology

This chapter introduces the methodology used in the study which is concerned with exploring how engagement in STEM subjects differs between boys and girls. This research is based on the critical assumption of the reality, which recognizes that “reality is shaped by social, political, economic, cultural, ethnic and gender values” (Guba & Lincoln, 1994, p. 109). Theoretically, my research is informed by post-structuralism, which is viewed as a set of approaches that help better understand and explain knowledge, identity, our social environment, and connection between the objects of inquiry, casting doubt on established values and meanings (Crick, 2016; Hardt, 1993). In this study, student engagement in STEM is viewed as social practice, while gender is considered as the behavior people demonstrate as the result of interaction with our social environment.

In this chapter, first, I discuss the rationale for employing a qualitative case study that complies with the research questions to be addressed. Next, I briefly describe the selection of the research site and sample and explain the procedure used in recruiting participants. Then, I present the data collection method which comprised two focus group discussions with Grade 12 students. I also explain the way I analyzed the collected data and reflect on my researcher positionality. A brief summary of the chapter is followed after the description of ethical considerations of the study.

Research Design

My study is an instrumental case study of one school for gifted students to generate theoretical ideas about the gendered nature of student engagement in STEM subjects. Lichtman (2014) argues that “a case-study approach is an in-depth examination of a particular case” which creates knowledge and understanding about a particular event or group (p. 119). Moreover, an instrumental case study examines a particular case in order to discern a theory or issue and determine the factors that may have contributed to that phenomenon (Stake,

1994). Therefore, this approach is justified in my research because it will enable me to explore the chosen phenomenon in depth within the real-life context of one school in south Kazakhstan (Yin, 2014).

Sampling procedures

This study used a purposeful sampling strategy to select 12 students in Year 12, who are 18 years of age or older. Purposeful sampling enabled me to select “information-rich cases” for in-depth study, as from such cases researchers “can learn a great deal about issues of central importance to the purpose of the inquiry” and gain a holistic understanding of the case (Patton, 2002, p. 273). Since the study was aimed at exploring how student engagement in STEM differs between boys and girls, gender and major choice were the main criteria for the sample selection. The sample comprised twelve students – six boys and six girls in Year 12 in one selective school with largely high ability students in south Kazakhstan. This grade has been selected because it is at this level students start actively making up their mind or are already certain about their future courses and careers. Furthermore, roughly half of participants were studying biology, while the second half were studying physics. The selection of these subjects reflect two different career choices: biology as a compulsory subject for medical fields, and physics for engineering. Both these fields are gendered in Kazakhstan, with women concentrated predominantly in medicine and men in engineering (UNESCO Bangkok, 2016).

Procedure of recruiting participants

Once ethical approval had been granted, the principal of the research site was contacted, and the aim and the importance of the study was explained to him. Ethical approval from NUGSE Ethics Committee and Information Letter were provided to the Principal. After I obtained an approval to collect data from students, Year 12 classroom tutors were asked to

provide me access to students to introduce my research and the consent process in detail.

Participants were recruited on a voluntary basis.

Prior to data collection, the students who had volunteered to participate in the study were given an information letter and consent forms. In addition, the description of the research, their role in it, the risks and benefits of their participation, the protection of their identity and confidentiality, as well as the voluntary nature of their participation were explained and discussed. Following this exchange of information, the researcher and participating students agreed on the date and language of data collection. Prior to data collection, the participants completed the consent form. On the day of data collection, the participants were reminded again about the voluntary nature of the research and their rights to withdraw at any time before the start or during data collection.

Data collection tools

The main data collection instrument comprised focus group discussion (FGD) with Year 12 students conducted in a quiet room within school premises. Two FGDs were conducted, each involving six students. The first FGD captured the views of physics students, while the second one reflected the views of biology students (Table 1). An equal number of girls and boys (three boys and three girls) participated in each FGD, as the study focused on gender differences in student engagement. FGDs were conducted with students because they are advantageous “when the interaction among interviewees will likely yield the best information, when interviewees are similar to and cooperative with each other or when individuals are hesitant to provide information in any type of interview” (Creswell, 2012, p. 218).

Since the research focused on student engagement in the classroom, FGDs allowed to “access group norms, values, and processes” (Rosaline, 2011, p. 146), and “gather multiple perspectives about the issue” (Heck, 2011, p. 380). This also allowed the researcher to see

gender dynamics at play that cannot be observed in a one-to-one interview. Moreover, FGDs minimize power relations and social hierarchies between the researcher and the participants who are younger in age and lower in authority relative to the researcher. This enabled gaining valuable data regarding the topic of the study.

Table 1				
<i>Data Collection Method and Sample Size</i>				
<u>Method</u>	<u>Specialization/ major subject</u>	<u>Year 12 Girls</u>	<u>Year 12 Boys</u>	<u>Total</u>
FGD1	Biology	3	3	6
FGD2	Physics	3	3	6
	Total	6	6	12

The discussions were conducted in Kazakh, as this was the language that participants found more comfortable in discussing their views. The composition of the FGDs was semi-structured, so the flow of the data collection process was regulated on the spot (see Appendix B, for the FGD guide). Some follow-up questions were asked to clarify certain responses of participants and delve deeper into the case. The FGD questions were created based on the research questions, the review of literature on the topic and theoretical framework chosen for the study. The participants were first asked more generic questions, suchlike the reason for their choice of a STEM subject, and what profession they would like to pursue before asking about their participation in STEM subjects in order to better understand students’ experience of STEM engagement. Each FGD lasted no more than 40 minutes. Despite the fact that all the participating students agreed to participate in the research voluntarily, a couple of participants (one boy and one girl) were not very open to give extensive answers or continuously sustain the discussion. Students’ natural shyness could explain the emergence of such an issue. Moreover, during the biology FGD, one of the participants suggested that this might be the reason, as they observed similar experience in their classes. With students’ consent, the

discussions were audio recorded pre-checking the quality of the recorder. This was done in order to accurately transcribe the participants' words.

Data analysis

Both FGDs were transcribed verbatim so that I would not miss any valuable data and could go back to the data and reflect on them during the analysis. Word-for-word transcription is considered tiresome, but it is one of the important aspects of a rigorous qualitative research process (Loubere, 2017). The transcribed data of two FGDs were kept separately, and all the participants were assigned pseudonyms to protect their personal information. I manually developed transcripts by moving back and forth between recordings and transcripts because they are used not only for data analysis, but also as evidence of “the author’s analytic claims” (Ashmore & Reed, 2005, p. 91). During the act of transcribing, researchers listen to the recordings several times, therefore analytical reflections may occur. Moreover, Saldaña (2018) strongly recommends that the researcher who conducted the conversation, transcribes the recordings, as such a researcher will be familiar with the field context and be able to create a more accurate document. I had cultural competence in the context of the research, as I am a native speaker of Kazakh.

Since the original talk was in Kazakh, the audio recordings were transcribed in the source language and then translated into English. By doing so, I could constantly check transcripts with translated interpretations during analysis to provide rigor (Lyons & Coyle, 2007). However, if a translator does not possess a thorough knowledge of the context and a high level of target language proficiency, translating the original conversation may lead to issues with little credibility of findings and loss of meaning (Jenks, 2018). Being a teacher of English, I have a reasonably high level of linguistic proficiency in the target language of translation. During this process, “backward-forward translation and examination of the translated meaning in both source and target languages” was carried out to ensure content

equivalence, not word-to-word equivalence (Regmi, Naidoo, & Pilkington, 2010, p. 20).

Furthermore, the translated text must be reproduced taking into account not only “the detail and nuance of the material being studied in its language-of-occurrence, but also the detail and nuance in comparable English language interactions” (Schegloff, 2002, pp. 262-263). In other words, translation as a part of the analysis should consider the peculiarities of the English language.

Following the transcription and translation of the recordings, the data were coded using different colors to facilitate analysis. About 40 codes were initially identified, which were subsequently organized into five themes (see Appendix D, for the codes and their convergence into the 5 main themes).

Researcher positionality

Since the sample of the study comes from the researcher’s workplace, I take a subjectivist posture, as my positionality is inseparable from the research findings. Therefore, the researcher’s positionality may affect the interpretation of the research findings. I suppose, however, that my insider positionality did not influence students’ answers during FGDs, because the flow of the discussions was relaxed and progressive. There are different levels of the insider-outsider positionality (Dunne, Pryor, & Yates, 2004). Although as a teacher in Kazakhstan, I could be classified as an “insider”, the fact that I do not teach STEM subjects, to some extent characterized me as an outsider to the research participants and helped me build trust with the participants. My insider status was, however, extremely helpful in gaining access to the school and participants.

Ethical considerations

Every effort to protect the participants’ confidentiality and anonymity was made. First, the aim, nature, stages and importance of the research were explained before the data collection. It was guaranteed to the participants that no personal data, except gender and the

subject of choice (physics or biology) would be identified. Participation in this study was strictly voluntary, and the participants were also guaranteed to withdraw from the research at any time without prejudice. They were informed that no one would have access to the raw data except the researcher conducting the study. When presenting findings, I did not identify the real names of the participants, the name of their school, and the city in which the study was conducted in order to keep their personal information confidential. Each student was assigned pseudonyms.

I transcribed and translated the audio materials myself without the assistance of external people to eliminate the possibility of data leakage. The consent forms are kept in a safe locked location, to which only the researcher have access. The electronic data (such as transcripts and the coded themes) are kept on the researcher's personal computer, which is password protected because "safely storing the data also ensures that you are honoring the confidentiality of participants – an essential ethical consideration" (Bloomberg & Volpe, 2012, p. 96).

Despite all the steps taken, there is a risk of breach of confidentiality in a group setting. Therefore, the participants were reminded of the risk during the recruitment process, and they were asked not to identify fellow students or disclose the contents of discussion. At the end of the FGDs, participants expressed that they recognize the importance of the ethical aspects of research, because they themselves conducted research in the 11th grade as part of one course.

Limitations of the study

The study explored the ways students' engagement in STEM subjects might be gendered in one specialized school. However, the experience and perspectives of students in mainstream schools may differ from what the research has revealed, as the research site is a selective school for students with high abilities. Thus, the findings of my study are limited to

high ability students. In addition, the school is rich in resources, especially for STEM subjects. Therefore, data in another context could have been collected in order to analyze whether findings vary across different school types. It was my intention to capture this diversity, but I was unable to do so because this would have meant undergoing a longer process of getting ethics approval. There were no students aged 18 years or older in mainstream schools, and researching those under 18 is classified as “high risk” research requiring parental consent. Hence, my application needed to go to the University Research Ethics Committee, which would take a longer time to get an approval. I only had limited time to complete this study.

Other elements, suchlike geographical location or the influence of socio-economic factors could have also been explored to determine their role in the emergence of differences in student engagement in STEM. The views of students studying other STEM subjects apart from physics and biology could be studied. The current study, nonetheless, had a sufficient amount of data for the case.

Another limitation of the study is related to several students’ responses during FGDs. Although all the participants did understand the questions and voluntarily agree to be part of the research, some students’ responses were not extensive either due to their personal traits (e.g. shyness) or they preferred not to participate extensively in the discussion. This, in its turn, to some extent affected the group dynamics during FGDs and resulted in certain students’ dominance. This issue was tackled by asking additional questions from not active participants in the FGDs and with the help of other participating students who tried to ask certain questions to those students who did not give detailed answers to maintain the flow of the discussion.

Summary

This chapter presented the research methodology used in the study to capture students' views on gendered student engagement in STEM. The use of a qualitative case study and FGDs was justified by the need to conduct an in-depth examination of the specified phenomenon. In addition, the chapter introduced participant recruitment and data collection procedures, ethical considerations and limitations of the study. The next chapter will present the findings of the research based on two FGDs.

Chapter 4: Findings

This chapter reports on the analysis of data collected from focus group discussions (FGDs) with Grade 12 students. The study sought to understand the ways in which student engagement in STEM might intersect with gender, the reasons for the emergence of any gender differences in student engagement, and the strategies that might enhance the engagement of both male and female students in STEM. Data were collected from students of one specialized school for high ability students in south Kazakhstan

The analysis presented draws on two FGDs in which 12 students participated, who were recruited using a purposeful sampling. The FGDs were organized on the basis of academic disciplines. One FGD (six students) was conducted with students who chose physics as their major, while another one (six students) was held with those who chose biology. Each FGD contained an equal number of male and female students, since the study is exploring the possible intersection of engagement and gender. The selection of these subjects reflects two different career choices: biology as a compulsory subject for medical fields, and physics for engineering. Both these fields are gendered in Kazakhstan, with women concentrated predominantly in medicine and men in engineering. The participants of the study were assigned pseudonyms in order to maintain their confidentiality.

The analysis of the data revealed five salient themes based on the participating students' experiences: student engagement in STEM, the fluidity of student engagement, gender and student engagement in STEM, the reasons for gender differences in student engagement, and the strategies that might enhance student engagement. In addition, a brief summary is given at the end of the chapter.

Students' engagement in STEM

In order to understand students' narratives of their engagement in STEM, it is helpful to first provide information on the gender of the participating students, as outlined in Table 2.

<u>Name</u>	<u>Gender</u>	<u>Subject of choice</u>
Symbat	female	Physics
Gulnaz	female	Physics
Akgul	female	Physics
Murat	male	Physics
Adilet	male	Physics
Alibek	male	Physics
Nurbolat	male	Biology
Bolat	male	Biology
Daniyar	male	Biology
Ainur	female	Biology
Aidana	female	Biology
Zhuldyzai	female	Biology

In order to get a sense of students' engagement in their selected major, that is, biology or physics, students were asked why they selected it. Three main reasons emerged behind students' selection including the significance of their selected subject, the relative ease with which they can perform in the subject and the extent to which they find the selected subject interesting.

Both physics and biology FGDs indicated that the perceived utility of the subject was linked to engagement, but that it was gendered. Murat's choice of physics was informed by the pragmatic reasons of the subject because "there are a lot of specialties and education grants for higher education when choosing physics". Bolat, however, replied that he chose biology, since "today many global problems are being solved in connection with Biology".

According to both FGDs, the reason behind the choice of physics or biology for the majority of girls (5 out of 6 girls) was that they found the chosen subject easier than other disciplines even though it would not be related to their future profession. However, all six male students in the study did not mention this option as a reason for their choice of the subject. For example, Symbat stated, "The reason I chose physics was that in the 10th grade, physics was easier for me than other subjects", while Zhuldyzai responded, "I chose biology

because it was easier for me, but I do not need biology myself. I chose it because I had to choose one subject of choice. I will not connect my future with biology”.

However, some participating males and one female indicated that they enjoy studying the subject, and that this subject is related to their future studies. For example, Alibek reported, “Physics is an interesting lesson. I am very interested in the field of Information Technology, and I want to know how everything in this sphere works. Physics is an obligatory subject for this field”. A female participant, Ainur, replied, “Biology is an interesting lesson for me. It is easy to research. You study every organism, you study your body – what is happening in your body, what organ has what functions and that is interesting. This attracted me”.

Students’ engagement in STEM subjects was found to be linked to their self-competence in the subject, and it often emerged as an issue in students’ discussion of their engagement in STEM. The research participants reported different levels of self-assessed knowledge and skills in physics and biology, from very low to high levels across girls and boys. For example, Daniyar, a boy, expressed, “I think my knowledge and skills in biology are relatively very low compared to other students. I do not have enough knowledge in biology to choose it as a profession; it is an optional choice for me”. By contrast, Symbat, a girl shared, “I think my knowledge of physics is very good”. My data indicated that students’ self-perceived knowledge and skills in STEM were not strongly linked to their gender.

Rather worryingly, several students have selected a major that they do not intend to study in the university. Only a couple of male students want to connect their future studies with physics. Adilet replied, “I see myself as a computer science specialist in the future. I plan to do not only engineering, but also research. In the distant future, maybe I will become an aerospace engineer”. However, girls would like to pursue careers in Architecture, Economics and Finance, International Relations, and Tourism that do not require taking an exam in

physics or biology. The evidence indicates that both girls and boys want to pursue careers that are in demand and financially profitable in Kazakhstan. Some of their responses are as follows:

Physics has nothing to do with the subjects I will study at university. I am choosing mathematics and geography to study Economics or Finance because they are the professions that will be in demand in the future and their demand will never die. In addition, the economy of Kazakhstan needs good economists to improve it. (Symbat)

I would like to focus on mathematics and geography to choose Accounting and Auditing. I strive for the profession that will be most profitable for me. I need a profession that will allow me to achieve my dreams, to achieve a high career to raise capital. In a market economy, it is necessary. (Daniyar)

My data suggest that most of the participants (girls and boys) seemed to choose physics or biology to study in high school because they had to choose a profile (compulsory) subject among physics, biology, computer science, and chemistry. Notably, no one who chose biology would like to pursue a career in medicine. This finding might imply that the choice of subjects in high school is not always determined by students' career plans.

Overall, the results showed that the participating students' choices of physics and biology were based on an understanding of the significance of STEM for their future, their self-confidence in their knowledge and skills in STEM, and their enjoyment of studying the subject, although not all of them are going to link their future careers with physics or biology. In this study, gender appeared to intersect with STEM engagement that is discussed later in section Gender and Student Engagement in STEM.

The Fluidity of Student Engagement in STEM

The analysis of the data collected from the two FGDs indicates that student engagement in STEM is not a permanent state but is fluid, and that students are engaged and

disengaged for several reasons. My data indicated that student engagement in STEM might differ by the topics studied and the alignment of topics with real life, with levels of students' participation in lessons dropping if students are not interested in certain topics. A female participant, Gulnaz, stated, "Engagement depends on the topic. If the topic is interesting, everyone will take part", while Adilet, a boy, replied, "I am very interested in topics, such as Quantum Physics, Nuclear Physics, Dynamics or Astrophysics. However, my engagement decreases when there are topics, such as Oscillation".

The participants' answers showed that student engagement in STEM also depended on whether the subject was related to their future career pursuits. For example, Akgul answered, "I think if students choose a lesson only as a profile (compulsory) lesson, but if it is not related to their future profession, they will not be very active in the lessons".

In terms of their learning in physics and biology, all the participants, with one exception, expressed their preferences for studying applied knowledge over abstract knowledge. Students stated that they do not like studying a lot of theory, and that they prefer to solve tasks using formulas and applying their problem-solving skills rather than memorizing definitions. Quite the opposite of other students, one female participant reported her interest in abstract knowledge, or theories, even though learning such knowledge can be more difficult than learning applied knowledge:

Physics is basically a lesson of problems. Sometimes in one term, we mostly study theories, and do not solve many physics problems. I do not like to solve tasks, and I cannot show myself from a good side at such times. As we did not solve problems that term, I got a high score in summative assessment [exam taken at the end of each term]. The next term, when there were only physics problems, my results dropped sharply. That is why I do not like to do physics problems.

(Akgul)

The participants also noted the impact of teacher's exposition on student engagement in the lesson. Students indicated that differences in student engagement in STEM subjects are manifested in how teachers explain the topic, organize work in the classroom, and monitor student behavior during the lesson. For instance, Murat replied, "I think the participation of students in the lessons depends on the way the teacher teaches. This is because some teachers continue to teach even if 2-4 students at the front desk are asleep; he who listens, will listen". Symbat highlighted teacher methodology, stating, "A qualified teacher will explain well even a boring topic. There will be topics that interest me. But if the teacher, who is explaining the topic, is monotonous, I want to sleep".

In general, the findings indicate that student engagement in STEM subjects is rather fluid as opposed to being a permanent state and that the same student can be engaged or disengaged depending on the lesson topics, students' interest and personal reasons regarding the attitudes towards the utility of the subject for their future studies, and teacher exposition.

Gender and Student Engagement in STEM

Despite some similarities in students' engagement in STEM, as discussed in the preceding two themes, my analysis of the data suggests that student engagement in STEM differs by gender in a range of ways. Comparing their participation in STEM subjects in secondary school, students rated their overall engagement in physics and biology in high school as low. For example, Akgul said, "We are not very active in high school because we are studying the topics that are repeated every year but studied in depth". However, when boys and girls estimated student engagement in their class, both female and male students reported a higher level of involvement of boys compared to girls in physics lessons, stating that boys are often more willing to solve physics problems in the classroom. Murat reflected on his classroom experience, stating:

I think it is mostly boys who are active. Boys are often asked to answer questions and solve tasks on the board. There are the boys who themselves want to solve tasks on the board, but the girls have to be asked. I think you can come to such a decision based on this.

This participant's response relates to the teacher role. It might suggest that teachers approach students differently, giving boys more opportunities to show their competence in the subject. This can signal a strong message to both girls and boys about who is perceived to be good at physics. In addition, one female participant, Akgul, replied, "We have a small group of girls in our class, so I think boys are more involved in physics lessons". All the participants in this FGD, however, replied that all students are treated the same by the teacher. This suggests that higher engagement of boys in physics could be associated with their large number in physics classes or alternatively students are not able to see the implicit ways teachers' practice might be gendered.

Gender also intersected with STEM when students' perceived competence and knowledge in their selected subject and whether they would pursue their major at tertiary level were considered. Even if girls feel confident and knowledgeable in the subject, they still prefer not to choose physics. However, some boys say that they are not very confident of their knowledge in physics, but they would nonetheless choose to study it at tertiary level for utilitarian reasons. A male participant, Alibek, stated,

In general, now I understand physics. However, I do not think that I will show high results in the upcoming external final exam, that is, I do not have confidence in physics. ... the subject of astronomy is integrated into physics. Apart from lessons, I am interested in this area. In my free time, I like to see and read information about space.

By contrast, Symbat, a girl, responded, “I think my knowledge of physics is very good. I like to solve tasks more than memorizing definitions, and I do it well, but physics has nothing to do with the subjects I will study at university”.

My data also indicated that some of my participants held norms of behavior as students in STEM which were gendered. First, even though not all participants would relate their future studies with Physics, mostly male students seemed to ask questions and are motivated enough to learn new things. Some students, both male and female lack confidence in the subject, yet boys are more eager to study physics for its utilitarian value. For example, Alibek replied, “I consider my level of participation in Physics to be average. When the teacher explains the topic to us, I ask as many questions as possible and I am eager to learn more about the new topic.”

Across the two FDGs, participants mentioned that female students often suppress their abilities in physics. They stated that many girls do not see the utility of physics, perhaps due to this reason they may not connect their future studies with the subject. Alibek, a boy, replied, “Many girls are afraid to choose physics; they are not allowed to study physics careers”, while a female student Ainur replied,

... when choosing physics, most specialties are technical specialties. In the past, it was said to girls that they should not work at factories. This has been happening for a long time. Girls usually suppress their ability then. ...For various reasons, they go to spheres related with chemistry and biology to become a doctor or a teacher.

Moreover, the physics FGD revealed that girls and boys are likely to perceive information and contribute to the lesson differently. For example, a male participant, Murat, noticed that while solving physics problems, girls often seem to be under pressure to follow order and avoid mistakes. He replied that when girls complete tasks, they feel the need to write everything correctly and in order. By contrast, when boys solve problems, they usually

do not even write units, but simply write what they are asked to find. Nevertheless, boys are still able to perform well at the tests. For example, Akgul stated, “Teachers say that everything should be written in order. For example, my teacher in middle school told me to write everything in order so as not to confuse anything”.

The participants’ answers suggest that boys do not necessarily conform to the rules prescribed by the teacher, but this does not mean they do not understand. Girls in the study appeared to show greater adherence to teachers’ directions, but this does not necessarily mean they have better understanding than boys. For example, Symbat, a girl, replied:

I need to write down and understand the terms of the task. Boys read the terms and immediately begin to find what is being asked. Boys understand the topic, even if they are not very active and do not listen to the teacher. However, I have to listen carefully from beginning to end, and only then, I will understand.

The finding suggests that teachers seem to expect adherence from girls, but boys are often excused for not complying with teachers’ expectations regarding how to produce work.

In general, I found that students’ decision to choose physics is gendered despite male students’ low and female students’ high levels of self-perceived confidence in the subject. In addition, certain student norms of behavior, such as solving problems and adhering to classroom rules, appeared to be gendered, despite the fact that girls, as well as boys, did not report explicit gender differences in how they are treated by their physics teachers.

Reasons for Gender Differences in Student Engagement in STEM

Students’ answers revealed several reasons for gender differences in student engagement in STEM subjects: cultural norms related to gender in Kazakhstani society, gendered classroom norms, and the utilitarian values of STEM.

Gendered cultural norms. Responses from participating students (both boys and girls) showed that girls are more likely to study biology, and boys are more likely to choose

physics as their future careers, due to the cultural context in Kazakhstan. For example, Alibek responded,

I think that gender differences may affect the discipline of choice because among our 12th grades, girls predominate in 12A and 12B classes, and their main subjects of choice are chemistry and biology. In the 12C and 12D classes, boys are predominant, and the subject of choice is physics. Many girls are afraid to choose physics; they are not allowed to study physics careers by their family (parents or husband).

Ainur also mentioned the family influence in choosing a profession, stating:

Girls usually suppress their ability then because, for example, in the future their husband may not allow them to work in technical spheres. I know such a person in real life, who graduated with honors in physics and mathematics but works as a technician at school. The reason was that her husband did not allow her to work according to her specialty. She studied the oil industry. So, it is because of family influence.

The evidence suggests that girls are often expected to adhere to gendered norms when choosing their future education as established by their parents or husband, even though their self-esteem and skills in physics are often quite high.

Gendered classroom norms. The participants' responses indicated that just like in families where girls are regulated more and expected to adhere to social norms, the same happens in the classroom with respect to classroom norms set by the teachers in physics and biology. Girls are under pressure to produce homework, while boys tend to get away with not doing it. Gulnaz, a girl, responded, "I think that before coming to the 11th grade, everyone had a different physics teacher. In the lower grades, the teacher taught us to write everything in detail so that everything is clear to the person checking." Ainur also noted a teacher role, that is, teachers' different approaches to how students do homework, responding:

Yes, if we do not do homework in biology, teachers scold the girls first. They say, “All right with boys, but why don’t you, girls, do homework?” In such cases, I notice such a different attitude to girls. Everyone is a student, there is no difference. Someone among girls might know well, and there might be someone who knows subjects well among boys. I do not like that kind of relationship.

The data suggest that girls are often expected to be more responsible than boys, and to always produce homework unlike boys who are often not penalized for not doing homework.

Perceived utility of STEM. Participants’ answers show that gender differences in STEM subjects are due to the utility of the subject in students’ future careers, as there is a higher number of education grants for university entry if they choose physics and mathematics. Mathematics is an obligatory subject for all students in high school.

Nonetheless, girls in the study are not planning to pursue careers in physics, unlike boys who seem to better realize the value of the subject for their future studies. For example, Murat replied, “By connecting physics with mathematics, there is an opportunity to enter many specialties in Kazakhstan. That was the reason for me”. Another male participant, Alibek, highlighted the connection of physics to his interests, stating:

I am very interested in the field of Information Technology, and ... Physics is an obligatory subject for this field. ... I participate in the Robotics Club, I use my knowledge of physics to build various circuits, work with sensors. I also participate in the recently established Aerospace Club.

Overall, the data suggest that societal norms on gender, gender norms in STEM classroom set by the teacher, and the future utility of STEM can explain gender differences in student engagement. Findings suggest that expectations from girls seem to be higher both inside and outside the classroom. Notably, none of the girls in this study want to pursue

careers in biology, which several participants mentioned as a subject that girls often choose as a career.

Strategies That Might Enhance Student Engagement in STEM

In order to identify strategies that could enhance the recruitment of men and particularly women in STEM subjects, the participants were asked what would make studying physics and biology more enjoyable. Both girls and boys studying biology highlighted the need to use more laboratory work, claiming that conducting experiments would make understanding the subject easier and more memorable, as they would conduct practical work on their own. Ainur replied, “I agree that experiments in biology are interesting. It is clearer and more memorable to try things out with your own hands than to go through theory”, while Nurbolat said, “For me, it’s also experiments. To have more practical work would make studying Biology more enjoyable for me”.

In the physics FGD, male students’ responses confirmed the previously mentioned position on the need for more practical work. For example, Murat stated, “I think we need more practice because there are so many interesting things in physics. If you see, touch and understand how something works, it will be clearer, more interesting and more effective than learning from the presentation” (Murat).

Boys also mentioned the benefits of solving physics problems as an approach to improve student engagement. Alibek responded, “I like working with formulas in physics. You will be able to solve problems by going through one or two formulas in each lesson. I think this will make it easier to understand the topic”.

Meanwhile, girls from the physics FGD underlined the use of group work to increase student engagement. Symbat pointed out the significance of such work in promoting reciprocal learning and reflection, stating:

In our group, our teacher divides us into three groups. If the teacher constantly explains, it will be boring. That is why sometimes we explain the lesson to each other, and then the topic will be clearer to us. During group work, we paint posters in different colors and thus, relieve stress. At the end of the term, we will again be divided into three groups. We will put up a poster to show what we learnt that term. It is interesting.

Moreover, females in the physics FDG noted that holding competitions would encourage students to actively participate in the lessons and achieve higher results. This is quite a significant finding because competitiveness is often seen as a masculine trait. Akgul responded,

I think when there is competition, people want to compete with each other and achieve great results. Because when we are divided into groups, ask each other questions and ask each other to complete a task, we want to be ahead of them, which in turn, encourages us to study more, learn faster than others, be active, and not get bored.

That way information will be received better. Maybe at the beginning of the lesson, we may have such tasks related to the topic.

Overall, the findings indicate that applying practical work, solving problems, group work and opportunities for competition might enhance the engagement of both girls and boys in STEM subjects.

Summary of the chapter

The purpose of this chapter was to present the findings drawn from two focus group discussions. The findings were organized into five themes: overall student engagement in STEM, the fluidity of student engagement, gender and student engagement in STEM, the reasons for gender differences in student engagement, and the strategies that might enhance student engagement in STEM. One significant finding was that student participation in STEM

is not static, that is, the same student can engage and disengage in the lessons depending on the topic, personal reasons and the role and pedagogy of teachers. Another important finding was that teachers seem to expect that girls will always complete homework, while boys are more likely to get away with not complying with teachers' expectations regarding how to produce work.

The next chapter discusses the findings in relation to existing studies on the similar topics, and explains how these findings can contribute to an increased understanding of the research topic.

Chapter 5: Discussion

In the previous chapter, I presented an analysis of the data collected based on two FGDs – one FGD with students who chose physics as their major and one FGD with students who chose biology. In this chapter, I discuss the main findings in relation to the research questions and existing literature on the topic. The chapter is organized into five sections. The first section considers overall student engagement in STEM, while the second section argues that student engagement is not a permanent, but a fluid state. The third section discusses gendered student engagement. The fourth section discusses the reasons for the emergence of gender differences in student engagement, whereas the last section suggests the strategies that might enhance student engagement in STEM. The concluding section summarizes the chapter.

Students' Engagement in STEM

In order to understand their engagement in STEM, students were asked why they selected physics or biology. The study identified three reasons for students to choose an elective subject in high school that is related to their future specialty. The reasons included how significant the selected subject is, how they can perform this subject, and how interested they are in the chosen subject. Similarly, a study of MBA students in Britain, Turkey and Israel highlighted the influence of students' own education, skills, competencies and abilities as the main factors that affect students' career choice (Özbilgin, Küskü, & Erdoğan, 2005).

Although my participants only offered the above three reasons for the choice of their major, some participants (both boys and girls) noted the influence of the family on the decisions of female students regarding their future profession in STEM areas. A range of studies also indicated the presence of traditional gender ideology in choosing STEM careers in different contexts (Belmonte, 2012; Dom & Gihong, 2018; Özkale et al., 2004), which is discussed later in section Gender and Student Engagement in STEM. Despite the presence of

gendered norms in choosing STEM subjects, my data indicated that students' self-perceived knowledge and skills in physics and biology range from very low to high levels across girls and boys. In other words, this difference cannot be solely linked to gender. This finding is consistent with the results of studies by Francis (2000) and Van der Vleuten et al. (2016), which argue that boys' and girls' self-perceived confidence in their STEM competence is not merely linked to their gender but to their individual preferences. That is to say, socially constructed gender norms on career choice might not affect how boys and girls estimate their mathematical and science capabilities. However, self-perceived competence in STEM is linked to student engagement, and I discuss this later in section Gender and Student Engagement in STEM.

The current study also revealed that students' choice of an elective subject, that is, physics or biology, might not always be determined by their future career plans. Some male and female participants indicated that their choice of a major was informed by the necessity to choose any STEM subject to study in high school to be recorded in their high school certificate, even if they would not associate their future studies with the chosen subject area. This finding implies that students' decisions are not always shaped by their interest in and preference for the subject in high school, although these elements are considered crucial for student engagement (Oakes, 1990). This might be due to a lack of subjects to choose from.

Furthermore, the perceived utility of STEM subjects was often linked to student engagement, but a gendered pattern was also observed in this facet, which is discussed in further sections. The more students realize the utility of STEM for their future, the more they seemed to be active in the classroom. In the current study, boys appeared to place a higher value on STEM compared to girls. Overall, the literature indicates some changes in gender stereotypes associated with mathematics. However, when choosing STEM, there is still a

binary gender dichotomy of what is male and female appropriate (Van der Vleuten et al., 2016).

The Fluidity of Student Engagement in STEM

Although there is proliferating literature on gender differences and student engagement in STEM, my study revealed a number of reasons for student engagement differences that were not mentioned in existing studies. I argue that student engagement in STEM is not static but fluid, and that the same students can be both engaged and disengaged for several reasons. The analysis of the data collected in this research indicates that student engagement in STEM may differ by the topics studied and the alignment of topics with real life, suggesting that students' participation in the lesson declines when they are not interested in specific topics, or when students do not see the connection of topics to real life. I could not find a similar finding in existing studies on the topic, which suggests that my study has filled a gap in the literature.

Furthermore, my study indicated that student engagement in STEM might also depend on whether the chosen STEM subject is related to students' future career pursuits. Several participants, both boys and girls reported that they chose physics or biology not because they would pursue a career in these subjects, but because they had to choose any STEM subject to study in high school in order to meet the requirements of high school curriculum and certification. This finding points that students might be more engaged in the subject if it is related to their future profession, regardless of gender. For example, in the case of mathematics, studies suggest, "even if students do not enjoy math, they will persist if they believe that it will be useful for their future careers" (Oakes, 1990, p. 173).

Students appeared to be engaged or disengaged in STEM due to their learning preferences. In my study, all the participants, with the exception of one girl, expressed their preferences for studying applied knowledge over abstract knowledge. Both male and female

students in the study reported that they do not like studying a lot of theory, but prefer solving tasks, using formulas, and applying their problem-solving skills. Students actively participate in the lesson when the preferred mode of learning is applied in the classroom. Severiens and Dam's (1994) study showed that boys prefer an abstract conceptualized style of learning more than girls do, while Sagala, Umam, Thahir, Saregar and Kurppa (2019) found male students' preference for practical learning. My study does not concur with any of the studies mentioned above, since the students' preference for abstract or applied knowledge did not differ by gender.

Teacher exposition was reported as another factor for student engagement in STEM. Differences in student engagement in STEM subjects are seen in how teachers explain the topic and organize work in the classroom, suggesting that an inactive way of delivering a lesson would make students less engaged. This finding is congruent with a number of studies, which argue that students are more engaged if teachers use interactive teaching methods and can create a supportive classroom environment (Fredricks et al., 2004; Sharma & Garg, 2015).

Overall, this study revealed that student engagement in STEM is not a permanent state. It may vary depending on the topics studied, learning preferences of students, attitudes towards the utility of the subject for their future studies, and exposition of the teacher, but not specifically students' gender.

Gender and Student Engagement in STEM

Although my study did not find gender as significantly shaping students' self-perceptions of their knowledge and skills in STEM or their preference for the use of the application over theory, I found that student engagement in STEM may differ by gender in a range of ways.

First, the choice of STEM careers is highly gendered. Participants noted that girls are often not allowed to pursue careers in STEM fields by their families; therefore, they seem to suppress their abilities and abandon STEM, as many families think that certain professions are not appropriate for girls. According to female engineering students in Lebanon, “strong opposition from the extended family and friends of the family, hostile engineering workplaces, compromises between family and career, and the feeling of isolation and marginalization in the masculine culture of engineering” hinder the choice of STEM by women (Mozahem et al., 2019, pp. 130-131). Özkale et al. (2004) also acknowledged the presence of traditional barriers in women’s engagement in STEM in Turkey. The authors pointed out “gender discrimination in the working life”, “the assumption that women could not succeed in some professions due to social and family responsibilities”, along with “the role given to men in the society and in the family” as the main factors that explain low female participation in STEM, particularly in engineering (p. 9.1427.4). Since Kazakhstan and Turkey have cultural similarities, the aforementioned reasons could be valid for Kazakhstan, as my research also revealed the influence of social norms regarding men and women in choosing a STEM career. Gender assessment in Kazakhstan also revealed the presence of gender stereotypes, which view women’s role to be associated with family and household chores (ADB, 2018). Similarly, Almukhambetova and Kuzhabekova (2020) point out gender stereotypes, arguing that there are different “societal culture and gender role expectations” for males and females in Kazakhstan, where “men are considered to be the main breadwinners, women are caretakers” (p. 13).

Scholars argue that implicit gender norms determine which choices are appropriate for boys or girls, as societies often consider science as a superior subject that is not suitable for girls (Belmonte, 2012; Dom & Gihong, 2018). Moreover, a study in the Netherlands (Van der Vleuten et al., 2016) showed that a traditional gender ideology, that is, what is “appropriate”

male and female behavior encourages boys to choose “more science-related subjects that are considered masculine subjects”, and influences girls to choose “art, language and humanities, which are typical feminine subjects” (p. 184). Likewise, Mendick (2005a) argues that “discourses are gendered; they inscribe mathematics as masculine”, making it difficult for girls to choose and succeed in mathematics (p. 217). In the Kazakhstani context, society views STEM as a masculine area (Almukhambetova & Kuzhabekova, 2020). This might suggest that gender disparity in choosing STEM is not related to the biological construct of men and women but depends on how the social environment (e.g. peers, family, teachers) conceptualizes gender norms, framing the profession as masculine or feminine.

Gender also intersected with STEM in relation to whether the study participants would pursue STEM in higher education. Even if girls in the study expressed high self-perceived competence in physics, they are not planning to pursue a career in STEM in university. By contrast, some boys who did not feel very confident in their knowledge of physics chose the subject because they realize the pragmatic reasons for choosing STEM for their future better than girls do. This finding is not consistent with numerous existing studies, which suggest that boys are more likely to have high self-confidence in STEM subjects (Brown et al, 2007; Nardi & Steward, 2003). Chan and Cheung (2018) argue that it is the gender-stereotypical beliefs in STEM that lower girls’ confidence, which usually result in abandoning the STEM pipeline.

Overall, boys seem to recognize the value of STEM better than girls (Francis, 2000), which again may indicate that the choice of a profession is based on gender stereotypes. For example, according to PISA 2012 results (OECD, 2013), 55% of male students expressed a greater intention to choose mathematics as a future major at university on average. However, PISA-2012 results for Kazakhstan indicated that girls scored 9 points more than boys in science, resulting in higher overall grades by 1.43 points. Despite a high overall enrolment rate of women in STEM-related programs at tertiary level (66.3%) in Kazakhstan, only 37%

of female students were studying engineering which indicates that women are more concentrated within the fields of biology, chemistry, and medicine as opposed to physics and engineering (UNESCO Bangkok, 2016). This allows me to assume the existence of gender norms in relation to the choice of a profession in Kazakhstan, as more women choose people-oriented STEM fields (e.g. medicine).

My study showed a higher level of involvement of boys compared to girls in physics lessons. This finding is congruent with studies by Martinez and Guzman (2013) and Stoet and Geary (2018), which reported a decline in girls' engagement in STEM, despite being actively involved in other subjects such as languages and art. My data showed that boys were asked to explain physics rules and solve problems on the board more frequently than girls, which implies teachers' different expectations of students in STEM, giving boys more opportunities to show who is good at physics. In other words, this implies that boys are likely to be encouraged more than girls by teachers to excel in physics, which signals binary gender-based stereotypes among teachers. However, students studying physics did not report explicit gender differences in how they are treated by their teacher.

Research shows that gender plays an important role when it comes to who is encouraged to study STEM by such significant actors as teachers, family members, and friends who strongly support boys to pursue an engineering career (Bennett et al., 2013; Mujtaba & Reiss, 2014). Teachers usually see girls' high achievement in STEM as a result of their hard work, but they continue to believe in boys' academic potential despite their low achievements (Maynard, 2002). Therefore, lack of an external motivation to study STEM and a less positive view of girls' abilities in the subject by teachers may explain a small proportion of women who plan to study STEM as a career. Although discourses indicate that women consider STEM to be a difficult problem (Mendick, 2005a), the girls participating in my study expressed a high level of confidence in their knowledge and skills in STEM, stating that their

choice of physics or biology was informed by the relative ease of the subject. My research suggests that higher engagement of boys can be caused by other reasons that are discussed later in the next section.

In the current study, gender differences were also seen in certain norms of student behavior in STEM regarding how to produce work and homework. In solving problems, girls are under pressure to follow order and avoid mistakes, while boys do not necessarily conform to the rules prescribed by the teacher, still being able to do the task well. Likewise, Sunderland (2004) stated higher expectations from girls to write “better and neater” than boys, and used a “boys will be boys” discourse to illustrate that it is commonly acceptable for boys to be untidy and messy in their written work, which again signals to gender-based norms in society (p. 93). Moreover, girls seem to have different approaches to doing homework, “with girls working more steadily and consistently, producing work, which was neater, more detailed and coherently planned, and showing more effort and resilience” (Younger & Warrington, 1996, p. 310). In her literature review, Zhu (2007) uses the term *gender stereotype threat* to explain gender differences in problem solving, which includes a stereotypical view of STEM, differentiated expectations and encouragement of males and females (p. 197). Overall, my data indicate that teachers seem to expect greater adherence to instructions from girls, but boys are often excused for not complying with teachers’ expectations regarding how to produce work. With the existence of such differential commitment and expectations, girls are often put at a disadvantage as learners in the classroom by teachers and male students (Renold, 2006).

Furthermore, teachers appear to expect girls to always produce homework, while boys are frequently excused for not doing homework. In general, male students are considered more reluctant to produce homework (Horne, 2000), while girls “expend greater effort on doing homework assignments and are less likely to come to class without homework” (Xu,

2006, p. 85). The findings suggest that there are different expectations from girls and boys in doing homework and in adherence to teacher's directions regarding how to produce work.

This again indicates the presence of gendered classroom norms, which I discuss in the section on the reasons for the emergence of gender differences.

Reasons for Gender Differences in Student Engagement in STEM

The participants' answers revealed several reasons for the emergence of gender differences in student engagement in STEM: gendered cultural norms in Kazakhstani society, gendered classroom norms, and attitudes towards the utility of STEM.

Gendered cultural norms. Participating students' (both boys and girls) responses show that girls are more likely to study biology, and boys are more likely to choose physics as their future careers due to the cultural norms on gender in Kazakhstan. In Kazakhstani society, girls are usually discouraged from pursuing STEM careers by their parents and teachers, which in turn leads to gendered student engagement in STEM (UNESCO Bangkok, 2016). There are also beliefs about the traditional roles of women associated largely with home and family than with other spheres, which is one of the reasons for a low concentration of women in STEM occupations (ADB, 2018). Society attributes STEM with the masculine traits that give men a greater sense of ability and competence to succeed in STEM fields, making it difficult for women to fit into its masculine culture (Mendick, 2005a). Studies suggest that the presence of gender stereotypes can cause differences in interest because girls are exposed to unequal STEM experiences from early ages (Cheryan et al. 2017; Reilly et al., 2015). Since children are exposed to the socially instilled conception of male and female appropriate careers from a young age, when it comes to choosing a career, girls opt for less masculine areas despite their interests and equal achievements with men (Almukhambetova & Kuzhabekova, 2020). In the current study, mostly boys' future studies were related to STEM,

which might explain the traditional dichotomy of linking females to the arts and males to the sciences.

Moreover, girls often experience gender stereotypes about their lack of competence in STEM. My study, on the contrary, did not reveal gender-related differences in self-perceived competence and skills. The evidence suggests that girls often should adhere to gendered norms when choosing their future education as established by their family, even though their self-esteem and skills in STEM are quite high.

Gendered classroom norms. The participants' responses indicate that just like in families where girls are regulated more and expected to adhere to social norms, the same can happen in the classroom with respect to classroom norms set by the teacher in physics and biology. Girls are under pressure to produce homework, while boys are often excused for not doing it. Studies found that teachers encourage boys to pursue STEM careers more but expect girls to adhere to the behavior of a good student, who works hard, follows prescribed rules, works cooperatively, and is academically able (Renold, 2006). In general, teachers identify these traits as characteristics of female students, which reflects gendered student practices in the classroom. Moreover, it appears that teachers initiate interactions with boys more than with girls, ask boys questions that are more challenging, and praise them, giving boys more opportunities to demonstrate their competence and skills, even though they do not fully follow the classroom rules (Jones & Dindia, 2004; Li, 1999; Sunderland, 2004). Although differential classroom experience for boys and girls is not often explicit, it can reduce girls' interest in STEM; therefore, it is important that teachers encourage the proper application of STEM skills for both boys and girls (Reilly et al., 2015).

Overall, my study showed that girls are often expected to be more responsible than boys, and to always produce homework unlike boys who are not often penalized for not doing homework.

Perceived utility of STEM. The study revealed that another reason for gender differences in STEM student engagement was related to the future utility of the subject for students' studies. There are more education grants for university entry for technical fields (OECD, 2017) usually seen as masculine professions. In the present study, boys seem to better realize the utility of STEM subjects, especially physics, for their future studies. Watt (2016) argues that girls possess a lower interest in mathematics, despite the same level of achievement as boys have. Since the extent to which students believe that a field is useful for their future affects their persistence in the subject and choice of career (Cheryan et al., 2017; Eccles & Wigfield, 2002; Oakes, 1990), the perceived utility of physics can explain the higher engagement of boys in the subject. Due to students' interest, the perceived utility of the subject and the presence of gendered cultural and classroom norms, I suggest that lower engagement of girls in the STEM pipeline may not be related to their ability.

Overall, the study suggests that societal norms on gender, gendered classroom norms in STEM subjects set by teachers, and the perceived utility of STEM can explain gender differences in student engagement. Findings indicate that expectations to comply with traditional gender norms from girls are higher both inside and outside the classroom, which suggests that those differences cannot be "attributable to their biological sex but to the differential treatment they receive" (Mujtaba & Reiss, 2014, p. 389). Interestingly, none of the girls in my study wanted to pursue a career in biology, where women's participation in STEM is claimed to be more concentrated than in physics or computer science (Cheryan et al., 2017; UNESCO Bangkok, 2016).

Strategies That Might Enhance Student Engagement in STEM

The study revealed several strategies that could make studying physics and biology more enjoyable and could enhance the recruitment of men and particularly women in STEM subjects. Both male and female students highlighted the need to use more practical laboratory

work in physics and biology, asserting that conducting experiments would make understanding the lessons easier and more memorable. Burkam et al. (1997) and Oakes (1990) also pointed out that the frequent use of science laboratory activities has a positive effect on the learning of all students, especially girls.

The study identified solving physics problems in the lesson as an approach to enhance student engagement and a better understanding of the topic. Kennedy and Odell's (2014) research reflects this finding, arguing that promoting problem-solving as one of the most relevant skills of the 21st century improves student engagement in STEM. Moreover, if students do the tasks they enjoy, they will be actively engaged in the lesson (Eccles & Wigfield, 2002). Since both girls and boys seem to like solving problems at similar rates (Baran, 2016), using this strategy would encourage the engagement of both male and female students in STEM.

As a strategy, working in small groups in STEM lessons not only engages students in the lesson but also makes the lessons more interesting and promotes reciprocal learning, especially for girls. Studies have found that girls benefit from cooperative strategies, and that working in small groups helps to create an equitable learning environment for girls in science and has a positive influence on their persistence in STEM disciplines (Oakes, 1990; Raes et al., 2014).

Meanwhile, the girls participating in my study noted the effectiveness of competitive classroom activities in promoting student engagement and high achievement in STEM subjects. Being competitive is generally seen as a masculine trait. This finding contradicts the results of the research by Fennema, Peterson, Carpenter and Lubinski (1990), which revealed that competition contributes to boys' mathematics attainment, but hinders girls' achievement. By contrast, Almukhambetova and Kuzhabekova's (2020) study in Kazakhstan found that competitive atmosphere in STEM-focused schools facilitated female students' interest in

STEM, which further influenced their career choices in the pipeline. Since the present study was conducted in the specialized school with largely high ability students, school features might explain high levels of girls' preference for competitions. I suggest that preference for participation in competitions cannot be restricted to students' gender, specifically in the context of Kazakhstan.

Overall, my study found that the use of hands-on activities, problem-solving tasks, small group activities, and competitions might enhance the engagement of both girls and boys in STEM subjects. Existing studies on the topic offer a range of other strategies to improve student engagement, which include choosing examples with both boys and girls, using female role models in the classroom, encouraging participation in-school and out-of-school programs, and providing internships for girls to learn more about different opportunities in STEM fields (Purcell, 2015; Skelton et al., 2006).

Conclusion

The purpose of this chapter was to discuss the findings of the present study in relation to existing studies on the topic. One of the main findings was that student engagement in STEM is not a permanent state, and that it may vary due to several reasons. The study found the presence of gender stereotypes in students' career choices and in the perceived utility of STEM as linked to student engagement. However, students' self-perceived competence was related to student engagement, not gender. The chapter also discussed the reasons for the emergence of gender differences in STEM engagement and revealed that gender differences in student engagement were linked to socially constructed gender practices and experiences, not to the biological characteristics of men and women. In addition, the strategies that might enhance student engagement, and several implications were given based on the findings.

In the next chapter, I summarize the main findings of the research and present implications for further studies.

Chapter 6: Conclusion

This chapter summarizes the findings of my study which sought to explore gender differences in year 12 students' school engagement in STEM subjects. The study identified the ways in which student participation in STEM differs between girls and boys, the reasons for the emergence of such differences, and strategies for enhancing student engagement in STEM subjects. The chapter is organized into three sections. The first section presents an overall summary of the study, revisiting research questions, while the second section presents recommendations to schools and curriculum developers. The final section provides implications for further research based on the findings of the study.

Revisiting research questions

In what ways does student engagement in STEM differ between boys and girls?

The study revealed that student engagement in STEM might differ between boys and girls in a range of ways. First, it appeared that the choice of STEM careers was highly gendered. Participants mentioned the influence of social environment on students' choice, which is very common in the Kazakhstani context. Girls are usually not allowed to pursue careers in STEM fields by their family; as a result, most of female students abandon STEM despite their abilities because many families think that certain professions are not appropriate for girls. Society frames STEM as masculine subjects, attaching a greater value to male subjects. This suggests that gendered pattern in choosing STEM is not related to biological differences between men and women but depends on how social environment constructs gender norms as to whether the profession is masculine or feminine.

Despite the presence of a gendered pattern in career choice, for the majority of female participants in the study (5 out of 6 girls) the reason behind their choice of physics or biology was that they found the chosen subject easier than other disciplines, while all six male students did not mention this reason. Interestingly, none of the girls would like to adopt a

profession linked to physics or biology, but several male students intend to choose a career connected to physics or biology. This finding highlights the significance of gender norms as well as career guidance, as participating students have been studying the subject in depth for two years and will take an exam in the subject that they do not intend to pursue in the future. Moreover, the participants expressed different levels of self-perceived competence that was linked to student engagement not gender. In other words, students are more likely to actively participate in the lesson when they understand the topic of the lesson well. The girls in this study reported high self-esteem of their knowledge and skills in the chosen subject, which contradicts the notions of lower abilities of female students in STEM reported in the global literature.

The perceived utility of the subject was also linked to student engagement, but it was gendered. Some boys in the study do not feel very confident in their knowledge of physics but chose the subject because they seem to realize the pragmatic value of STEM for their future better than girls, as the government of Kazakhstan allocates more educational grants for specialties related to physics to study at tertiary level. Even if the girls have high self-perceived competence in physics, they still will not pursue a career in STEM in university, since the vast majority of physics-related professions are technical which are viewed as careers not suitable for women. This indicates gender differences in the utility value of STEM that are linked to gender stereotypes.

The current study showed a higher level of involvement of boys compared to girls in physics lessons. Boys more frequently than girls were asked to explain physics rules, answer more complex questions and solve problems on the board, which might imply that teachers treated students differently, giving boys more opportunities to show who is good at physics. However, students themselves did not report explicit gender differences in the classroom.

Gender differences were also seen in certain norms of student behavior in STEM regarding how to produce work and homework. It seems that girls are under pressure to follow order and avoid mistakes in solving problems. While boys do not necessarily conform to the rules prescribed by the teacher, they are still able to do the task well. Girls are expected to always produce homework, while boys are often excused for not doing homework and are not penalized. The findings suggest the presence of different expectations towards girls and boys in doing homework and in adherence to teachers' directions regarding how to produce work.

In addition to gender differences, the current study showed much nuanced perspectives about student engagement in STEM. Although there is much literature about gender differences, the findings of this research indicate that there are also a range of other reasons for student engagement that were not mentioned in existing studies on the topic, which suggests that my study have made important contribution to the literature. The study revealed a critical stance that student engagement in STEM is not static, that the same students can be engaged and disengaged for several reasons. First, student engagement might vary due to students' interest in the topics studied and the alignment of those topics with real life, suggesting that students might not engage in the lesson when they are not interested in specific topics, or when students do not see the real life use of the topics. Second, students are more likely to engage in the lessons if the selected STEM subject is related to their future career pursuits, regardless of gender. However, the majority of participants (three male and five female students) in the study do not associate their future with STEM fields. Students in the study reported that they chose physics or biology because they had to choose any STEM subject to study in high school for school leaving certificate according to the requirements of high school curriculum. This finding points that students are likely to be more engaged in the subject if it is related to their future profession. Third, student engagement may differ

depending on students' preferred learning style (theoretical or applied knowledge), that is, students actively participate in the lessons when their preferred style of learning is applied. The students' preference for abstract or applied knowledge did not differ significantly by gender in this study, as all participants with one exception, a girl, prefer applied knowledge. This contradicts the results of several studies, which link the preference for practical learning with a masculine trait. Finally, differences in student engagement in STEM subjects are depicted in how teachers explain the topic and organize work in the classroom, suggesting that an active way of delivering lessons would make students more engaged.

What reasons can explain gender differences in student engagement in STEM if they emerge? The study revealed several reasons for the emergence of gender differences in student engagement in STEM that are not linked to biological differences between girls and boys. The reasons include the gender norms existing in Kazakhstani society, gendered classroom norms, and perceptions of the utility STEM which in turn is gendered.

In Kazakhstani society, girls are more likely to study biology, and boys are more likely to choose physics as their future careers due to the cultural norms on gender in the country. Girls are usually discouraged to pursue STEM careers by their parents and teachers, which in turn leads to gendered student engagement with STEM. Despite overall positive cultural norms towards the concept of gender equality in the country, notions on the traditional role of women, which is associated with family and household chores still persist (ADB, 2018). When it comes to choosing a profession, girls seem to choose less masculine areas despite their interests and abilities, as from a young age children learn to categorize careers into those suitable for men and women in the family. It appears that girls often have to adhere to the gendered norms when choosing their future education as established by their family, even though their self-esteem and skills in STEM are quite high.

Just like in families where girls are expected to adhere to social norms, the same happens in the classroom with respect to classroom norms set by the teacher. Teachers seem to encourage boys more to do well in STEM, but expect girls to always produce homework, work hard, be responsible and adhere to the behavior of a good student, while boys get away with not following the rules or not doing homework. The findings reflected gendered student practices in the classroom that are related to gendered norms practiced by teachers.

The future utility of the subject for students' career was found to be another reason for gender differences in STEM student engagement. Since boys seem to better recognize the utility value of STEM, this factor explains why they are more engaged than girls in physics. However, none of the girls in the study wanted to pursue a career in biology, which is considered a female-dominated area.

Overall, this study suggests that lower engagement of girls in the STEM pipeline cannot be attributed to their biological characteristics but to gendered norms and practice they are exposed to.

What strategies might enhance the engagement of students, both girls and boys, in STEM? The study found that using hands-on activities in physics and biology very often would enhance the engagement of both boys and girls, making it easier to understand and remember the lessons. In addition, solving physics problems along with working in small groups might improve student engagement in physics lessons, make the lesson more interesting and promote reciprocal learning, especially for girls. Using competitive classroom activities were also found to promote student engagement and high achievement in STEM subjects. Being competitive is generally seen as a masculine trait, but girls in this study mentioned this aspect as an effective strategy for promoting their engagement.

Other strategies that might enhance the engagement of both girls and boys include choosing examples with both boys and girls, using female role models in the classroom,

encouraging participation in school and out-of-school activities and programs, especially for girls to learn more about the opportunities in STEM areas. The issue of how to make theory interesting for girls and boys could also be addressed using those strategies, since theoretical knowledge was not liked by many students in the study.

To conclude, the study did not find any fundamental differences between the ways girls and boys engage with STEM that can be linked to their biological differences. It is socially constructed gender norms that regulated students' practice and behaviors including engagement in STEM.

Recommendations: schools and curriculum developers

The research findings have contributed to better understanding of how student engagement in STEM differs between boys and girls. The research presents several recommendations for engaging students in STEM, in particular girls. First, female students should be more exposed to hands-on activities inside and outside the classroom because STEM-based experience can reduce gender differences and contribute to long-term equal gender representation in STEM (Dom & Gihong, 2018).

In addition, working in small groups should be promoted, since an equitable learning environment for girls in science has a positive influence on their persistence in STEM disciplines (Oakes, 1990; Raes et al., 2014). While working in small groups, the composition of groups should be carefully considered to select the grouping strategies that have a more positive influence on students' learning in STEM.

Understanding the factors that influence students' choice of major is important to organize and deliver better informed career guidance (Hunt & Michael, 1983), since gendered cultural and classroom norms still persist. Moreover, gender-responsive career counselling programs should be designed for secondary school students to facilitate them making an informed career decision before high school. In the long term, pre-service and in-service

teachers would need to be trained to practice gender-sensitive teaching strategies so that all students can realize their full potential (UNESCO Bangkok, 2016). The revision of textbooks and curricula materials should also be conducted to ensure that they do not promote gender stereotypes (p. 4). It is important that schools and teachers also work with parents and families to combat the gendered norms they hold which also influences girls' engagement and aspirations in STEM.

Finally, the combination of subjects to choose for studying in high school needs to be reconsidered, because eight out of twelve students in the study are not going to connect their future career with the subject, which they have intensively studied for two years.

Implications for further research

This research focused on exploring Grade 12 students' experiences to understand student engagement in STEM subjects using a qualitative case study design. The study could be extended by examining the views of students who study other STEM subjects, for instance, chemistry and computer science. This would allow seeing the full picture of student engagement in STEM.

Since the present study was conducted only in one school with largely high ability students, a similar study in a mainstream school would also illuminate useful insights. Another possible area for further research could be to study the perspectives of students from urban and rural mainstream schools using a multiple case study approach to analyze the impact of socio-economic factors on students' choice of and engagement with STEM fields, as school and geographical contexts may differ. In addition to a case study method, the analysis of STEM coursebooks could be reviewed to see whether there are any gendered patterns that might hinder the engagement of both boys and girls.

An ethnographic study of classroom practice and discussions with teachers would also reveal important insights. The study could infer this from students' talk but a researcher who

is alert to discerning gendered practice and talk would obtain rich insights through observing STEM classrooms and talking to teachers.

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Appendices

Appendix A

Student Informed Consent Form

I, _____, give my consent to participate in the study entitled “Gender differences of Grade 12 students’ engagement in STEM subjects: A case study of one specialized school in south Kazakhstan”. I understand that as a participant in the study, I will participate in one focus group discussion. I understand that the discussion will last about 40 minutes and will be audio recorded.

RISKS AND BENEFITS. Only your gender and the subject of choice (biology or physics) will be revealed during the analysis of the collected data. There is a risk of breach of confidentiality in a group setting, but all the focus group participants will be asked not to disclose the content of the discussion and participants to others.

Data collected during the research will help gain experience of participating in focus group discussions, and will provide the opportunity to share your views on the topic, as well as to find out your peers’ views in the group interaction. The findings will also help identify how boys and girls engage in STEM subjects and what encourages student engagement in the class.

CONFIDENTIALITY & PRIVACY. Any information that is obtained during this study will be kept confidential to the full extent possible. However confidentiality cannot be guaranteed fully because focus group discussion requires the participation of other participants. All the participants will be assigned pseudonyms, and only the researcher will have access to the records and collected data. The personal computer of the researcher will be protected with a password. The data collected will not be used to evaluate student performance or as a system assessment. The results of this research study will be published as a Master’s Degree Thesis work and may be presented at scientific or professional meetings or

published in scientific journals, but your name and the name of your school will not be associated with the research findings in any way.

VOLUNTARY NATURE OF THE STUDY. Participation in this study is strictly voluntary, and if agreement to participation is given, it can be withdrawn at any time without prejudice.

You have the right to refuse to answer particular questions. **The alternative is not to participate.**

CONTACT INFORMATION. If you have any questions, concerns or complaints about this research, its procedures, risks and benefits, contact:

- the principal researcher of the study: Akmaral Dauletliyeva,
akmaral.dauletliyeva@nu.edu.kz, +77074531050;
- the Thesis Supervisor for this research: Naureen Durrani,
naureen.durrani@nu.edu.kz;
- the Nazarbayev University Institutional Research Ethics Committee,
gse_researchcommittee@nu.edu.kz

Please sign this consent form if you agree to participate in this study.

- I have carefully read the information provided;
- I have been given full information regarding the purpose and procedures of the study;
- I understand how the data collected will be used, and that any confidential information will be seen only by the researchers and will not be revealed to anyone else;
- I understand that I am free to withdraw from the study at any time without giving a reason;
- With full knowledge of all foregoing, I agree, of my own free will, to participate in this study.

Participant's name _____

Signature: _____

Date: _____

The extra copy of this signed and dated consent form is for you to keep.

Студенттің келісім формасы

Мен, _____, 12-сынып оқушыларының STEM (ғылым, технология, инженерия және математика) сабақтарына қатысуындағы гендерлік айырмашылықтарды зерттеуге бағытталған зерттеу жұмысына қатысуға келісімді беремін.

Зерттеудің қатысушысы ретінде бір фокус топтағы талқылауға қатысатынымды түсінемін. Талқылаудың ұзақтығы шамамен 40 минут екендігін және оның диктофонға жазылатынын түсінемін.

ЗЕРТТЕУ ЖҰМЫСЫНА ҚАТЫСУДЫҢ ҚАУПІ МЕН АРТЫҚШЫЛЫҚТАРЫ.

Маған жеке сұрақтар қойылмайтындықтан, сондай-ақ менің және мектептің аты ешжерде ашып көрсетілмейтіндіктен, мен аталмыш зерттеуге қатысудың әлеуетті қаупінің жоғын түсінемін. Дегенмен, топтық талқылау кезінде менен басқа қатысушылардың болатындығын ескере отырып, басқалардың жеке басымды анықтау ықтималдығы барын түсінемін. Мен мектеп әкімшілігінің деректерге қол жеткізу мүмкіншілігінің жоқтығын және деректер мектептегі баға немесе жүйені бағалау ретінде пайдаланылмайтындығын түсінемін.

Зерттеу барысында жиналған барлық деректер бұғатталған файл арқылы қорғалатынын және бастапқы деректер тек зерттеушіге ғана қолжетімді болатынын түсінемін.

Зерттеудің маған тікелей пайдасы болмаса да, алынған ақпарат зерттеуші мен білім саласының мамандарына ұлдар мен қыздардың STEM пәндеріне қалай қатысатынын, сонымен қатар STEM пәндеріне студенттердің қатысуын ынталандыратын және әлсірететін факторларды анықтауға септігін тигізеді. Бұл ақпарат өз кезегінде STEM саласына ерлер мен әйелдердің қызмет етуін арттыру

стратегиясын анықтауға көмектеседі. Мен зерттеу нәтижелерінің қорытындысын қажет болған жағдайда электронды пошта арқылы ала алатындығымды түсінемін.

ҚАТЫСУШЫ ҚҰҚЫҚТАРЫ: Мен зерттеуге қатысуым ерікті екенін және кез-келген уақытта зерттеу жұмысына қатысу туралы келісімді кері қайтарып, оған қатысудан бас тартуыма құқығым барын түсінемін. Зерттеуге қатысудан бас тартқаным мен туралы пайымды пікір шығаруға себеп болмайтынын түсінемін. Топтық талқылау кезінде қандай да бір сұрақтарға жауап беруден бас тартуға құқығым барын түсінемін. Деректердің сақталуын қамтамасыз ету үшін зерттеуші фокус топтағы талқылауды диктофонға жазып отыратынын түсінемін. Мен зерттеу жұмысының нәтижелері ғылыми-зерттеу мақсаттарында ғана қолдана алатындығын түсінемін.

БАЙЛАНЫС АҚПАРАТЫ: Мен жүргізіліп отырған зерттеу жұмысы, оның тәртібі, қаупі мен артықшылықтары туралы сұрақтарым немесе шағымым болса, төмендегі тұлғаларға хабарласуға болады:

- негізгі зерттеуші Даулетиярова Акмаралға, akmaral.dauletiyarova@nu.edu.kz,
+77074531050;
- магистрлік зерттеудің ғылыми жетекшісі Наурин Дурраниге,
naureen.durrani@nu.edu.kz;
- Назарбаев Университетінің ғылыми-этикалық комитетіне
gse_researchcommittee@nu.edu.kz

Мен аталмыш зерттеуге қатысу шарттарын оқып, түсіндім. Мен зерттеуге қатысуға келісемін.

Қатысушының аты-жөні: _____

Қолы: _____ Күні: _____

Форма информационного согласия студента

Я, _____, даю свое согласие на участие в исследовании по изучению гендерных различий участия учащихся 12 классов в предметах STEM (наука, технологии, инженерия и математика). Я понимаю, что в качестве участника исследования, я приму участие в одном обсуждении в фокус-группе. Я понимаю, что обсуждение будет длиться примерно 40 минут и будет записано на диктофон.

РИСКИ И ПРЕИМУЩЕСТВА: Я понимаю, что потенциальных рисков, связанных с этим исследованием, нет, так как мне не будут заданы деликатные вопросы и моя личность, как и название школы, не будут раскрыты. Тем не менее, я понимаю, что есть вероятность определения моей личности людьми, которые будут участвовать со мной в обсуждении в фокус-группе. Я понимаю, что у администрации моей школы доступа к данным не будет и, что эти данные не будут использоваться в качестве школьной оценки или оценки системы.

Я понимаю, что все данные, собранные во время исследования, будут защищены в заблокированном файле и, что только исследователь будет иметь доступ к первичным данным.

Я понимаю, что, даже если для меня никакой непосредственной выгоды от исследования не будет, полученная информация может помочь как исследователям, так и специалистам в области образования лучше понять, как мальчики и девочки вовлечены в предметы STEM, а также выяснить, что стимулирует и что ослабляет вовлеченность студентов в предметы STEM, что может потенциально определить стратегии для повышения вовлеченности мужчин и женщин в карьере STEM.

Я понимаю, что, если пожелаю, я могу получить изложение результатов исследования по электронной почте.

ПРАВА УЧАСТНИКОВ: Я понимаю, что мое участие является добровольным и что у меня есть право отозвать свое согласие и прекратить участие в исследовании в любое время. Я понимаю, что мой отказ от участия в исследовании не станет причиной вынесения какого-либо оценочного суждения обо мне.

Я понимаю, что исследователь будет записывать обсуждение в группе на диктофон, в целях обеспечения сохранности данных. Я понимаю, что результаты данного исследования могут быть использованы исключительно в научных целях.

КОНТАКТНАЯ ИНФОРМАЦИЯ. Я понимаю, что в случае возникновения каких-либо вопросов или комментариев, замечания или жалобы относительно этого проекта можно связаться с:

- главным исследователем данной работы, Даулетияровой Акмарал,
akmaral.dauletiyarova@nu.edu.kz, +77074531050;
- научным руководителем исследования Наурин Дуррани,
naureen.durrani@nu.edu.kz;
- комитетом по этике институциональных исследований Назарбаев
Университета, gse_researchcommittee@nu.edu.kz

**Я прочитал и принимаю условия участия в этом исследовании. Я согласен/
согласна участвовать в исследовании.**

ФИО участника: _____

Дата подписания: _____

Пожалуйста, сохраните копию этой подписанной и датированной формы согласия.

Appendix B

Focus Group Discussion Guide

Title: Gender differences in Grade 12 students' engagement in STEM subjects: A case study of one specialized school in South Kazakhstan

Date: _____

Time: _____

Participants' names: _____

[After introducing myself, I thank the participants for their agreement to participate in the focus group discussion. I remind them of the purpose, significance, measure taken to ensure their confidentiality and the approximate duration of the talk.]

[I ask the participants to read the informed consent form and sign it if they agree to participate in the discussion. I ask them permission to audio record the discussion. With the participants' permission, I start recording the discussion.]

Focus group discussion questions:

1. What is your reason for choosing biology/ physics?
2. What career do you want to pursue? Why?
3. How confident are you of your knowledge and skills in biology/ physics? What evidence are you drawing on (e.g. grades, teacher appreciation)?
4. How would you describe your engagement in / with biology/ physics inside the classroom? And outside the classroom? (cues, private study time, participation in classroom activities or experiments; volunteering to answer or lead on projects?)
5. Do you think girls/boys are treated differently or they behave differently in biology/ physics classroom? (e.g. teacher questions, assignment of leadership roles in classroom)

activities, teacher praise and feedback; student volunteering to respond/ take a leadership role or initiate a question/ discussion)

6. What do you not like about studying biology/ physics?
7. What would make studying biology/ physics more enjoyable for you?
8. What would make studying biology/ physics more meaningful for you?

[I thank the participants for participating in the discussion. I again ask them not to disclose the content of the discussion and participants to others.]

Фокус топтағы талқылау хаттамасы

Тақырыбы: 12-сынып оқушыларының STEM пәндеріне қатысуындағы гендерлік айырмашылықтар: Оңтүстік Қазақстандағы бір арнайы мектептегі зерттеу.

Күні: _____

Уақыты: _____

Қатысушылардың есімі: _____

[Өзімді таныстырып болғаннан кейін, қатысушыларға фокус-топтың талқылауына қатысуға келіскендері үшін алғыс айтамын. Қатысушыларға зерттеудің мақсатын, маңыздылығын, олардың құпиялығын қамтамасыз ету үшін қабылданған шараларды және талқылаудың шамамен ұзақтығын еске саламын.]

[Қатысушылардан зерттеуге қатысуға келісім формасын оқып, талқылауға қатысуға келіскен жағдайда қол қоюын сұраймын. Мен олардан талқылауды аудиоға жазуға рұқсат сұраймын. Қатысушылардың рұқсатымен мен талқылауды жазуды бастаймын.]

Фокус-топтағы талқылауға арналған сұрақтар

1. Сіздің биология / физика пәнін таңдауыңыздың себебі неде?
 2. Сіз қандай мансаппен айналысуды қалайсыз? Не себепті?
 3. Сіз биология / физика саласындағы біліміңіз бен дағдыларыңызға қаншалықты сенімдісіз? Сіз мұндай жауапты не нәрсеге / қандай дәлелдерге сүйеніп беріп отырсыз?
 4. Сыныптағы биология / физика сабақтарына қатысуыңызды қалай сипаттайсыз?
- Сыныптан тыс уақыттағы қатысуды ше? (кеңестер, жеке оқу уақыты, сабаққа қатысу немесе сыныптағы тәжірибелерге қатысу, жобаларға қатысу/ жауап беру немесе көшбасшылық жасауға дайын болу және т.б.)

5. Сіздің ойыңызша, қыздарға / ұлдарға басқаша қарым-қатынас жасалады ма немесе ұлдар/ қыздар биология/ физика сабақтарында өздерін өзгеше ұстайды ма? (мысалы, мұғалімнің сұрақтары, сыныптағы көшбасшылық рөлдерді бөлу, мұғалімнің мадақтауы және кері байланыс; оқушылардың көшбасшылық рөлі атқаруға дайын болуы, немесе сұрақтар қойып, пікірталас бастауы және т.б.)
6. Биология / физика пәндерін оқығанда сізге не ұнамайды?
7. Сізге биологияны / физиканы оқып үйренуді не жағымды етер еді?
8. Не нәрсе биологияны / физиканы үйренуді сіз үшін неғұрлым мағыналы/ маңызды етеді?

[Мен қатысушыларға пікірталасқа қатысқандары үшін алғыс айтамын. Мен тағы да олардан талқылаудың мазмұнын және қатысушыларды басқаларға жарияламауын сұраймын.]

Протокол обсуждения в фокус группе

Тема исследования: Гендерные различия в вовлеченности учащихся 12 классов в предметы STEM: пример одной специализированной школы в Южном Казахстане.

Дата: _____

Время: _____

Имена участников: _____

[Представившись, я поблагодарю участников за их согласие участвовать в обсуждении в фокус-группе. Я напомню им о цели, значимости, мерах, принятых для обеспечения их конфиденциальности, и о приблизительной продолжительности беседы.]

[Я попрошу участников прочитать форму информированного согласия и подписать его, если они согласятся участвовать в обсуждении. Я спрошу у них разрешения на аудиозапись обсуждения. С разрешения участников я начну запись обсуждения.]

Вопросы для обсуждения в фокус-группах

1. Какова ваша причина выбора предмета биологии/физики?
2. Какой карьерой вы хотите заниматься? Почему?
3. Насколько вы уверены в своих знаниях и навыках в области биологии/физики? На что/какие доказательства вы опираетесь?
4. Как бы вы описали свое участие на уроках биологии/физики в классе? А как насчет внеклассного времени? (подсказки, время индивидуального обучения, участие в занятиях или экспериментах в классе и т. д. ; готовность отвечать или руководить проектами и т. д.)
5. Как вы думаете, относятся ли к девочкам / мальчикам по-разному или ведут ли они себя по-разному в классе биологии / физики? (например, вопросы учителя,

распределение руководящих ролей в классе, похвала учителя и обратная связь; учащийся добровольно отвечает/берет на себя руководящую роль или начинает задавать вопрос/дискуссию и т.д.)

6. Что вам не нравится в изучении биологии/физики?

7. Что сделало бы/сделает изучение биологии/физики более приятным для вас?

8. Что сделало бы/сделает изучение биологии/физики более значимым для вас?

[Я поблагодарю участников за участие в обсуждении. Я еще раз попрошу их не раскрывать содержание обсуждения и участников другим лицам.]

Appendix C

Information Letter for Recruiting Participants

Dear Participant!

I am *Akmaral Dauletiyarova*, a Master's degree student at Nazarbayev University. I am going to conduct research about gender differences of Grade 12 students' engagement in STEM (Science, Technology, Engineering, and Mathematics) subjects. I invite you to participate in the study because Your experience and views on the issue will be very valuable to explore the issue in-depth.

You will participate in focus group discussion which will take approximately 40 minutes. Only your gender and the subject of choice (biology or physics) will be revealed during the analysis of the collected data. All the participants will be asked not to identify themselves and others, but there is a risk of breach of confidentiality in a group setting.

Any information that is obtained during this study will be kept confidential to the full extent possible. All efforts, within reason, will be made to keep your personal information in your research record confidential. All the participants will be assigned pseudonyms, and only the researcher will have access to the records and collected data. The personal computer of the researcher will be protected with a password. The data collected will not be used to evaluate your performance at school or as a system assessment.

Your participation in this study is strictly voluntary, and if agreement to participation is given, it can be withdrawn at any time without prejudice. You have the right to refuse to answer particular questions.

If you want to participate in this study or have any questions regarding this project, please contact me via email or telephone number written below.

Email: akmaral.dauletiyarova@nu.edu.kz

Tel. number: +77074531050

Құрметті Қатысушы!

Мен, *Даулетиярова Акмарал*, Назарбаев Университетінің магистранты, STEM (ғылым, технология, инженерия және математика) пәндеріне 12-сынып оқушыларының қатысуындағы гендерлік айырмашылықтар туралы зерттеу жүргізгелі жатырмын. Сізді осы зерттеуге қатысуға шақырамын, себебі Сіздің тәжірибеңіз бен осы мәселе бойынша пікіріңіз тақырыпты терең зерттеу үшін өте пайдалы болады.

Сіз шамамен 40 минутты құрайтын фокус-топтың талқылауына қатысасыз. Жиналған деректерді талдау барысында тек сіздің жынысыңыз бен таңдау пәніңіз (биология немесе физика) көпшілікке мәлім болады. Барлық қатысушылардан өздерінің және басқа қатысушылардың аты-жөнін ешкімге жарияламау сұралады, алайда топтық жағдайда құпиялылықтың сақталмау қаупі бар.

Осы зерттеу барысында алынған барлық ақпарат мүмкіндігінше құпия болып қалады. Зерттеу жазбаларында сіздің жеке ақпаратыңыздың құпиялығын сақтау үшін барлық шаралар жасалады, бірақ топтық жағдайда толық құпиялылыққа кепілдік берілмейді. Барлық қатысушыларға лақап аттар беріліп, жазбалар мен жиналған мәліметтер тек зерттеушіге ғана қолжетімді болады. Зерттеушінің жеке компьютері құпиясөзбен (пароль) қорғалатын болады. Жиналған деректер мектептегі үлгерімді бағалау үшін немесе жүйені бағалау үшін пайдаланылмайды.

Сіздің осы зерттеуге қатысуыңыз ерікті түрде болып табылады. Егер зерттеуге қатысуға келісім берілсе, одан кез келген уақытта бас тартуға болады. Сіз кейбір сұрақтарға жауап беруден бас тартуға құқығыңыз бар.

Егер сізде осы жобаға қатысуға тілек білдірсеңіз немесе зерттеуге қатысты сұрақтарыңыз болса, маған төменде көрсетілген электрондық пошта немесе телефон нөмірі арқылы хабарласуыңызға болады.

Электронды пошта: akmaral.dauletiyarova@nu.edu.kz Телефон нөмірі: +77074531050

Уважаемый Участник!

Я, *Даулетиярова Акмарал*, студент магистратуры в Назарбаев Университете, собираюсь провести исследование о гендерных различиях участия учащихся 12 классов в предметах STEM (наука, технологии, инженерия и математика). Я приглашаю Вас принять участие в данном исследовании, потому что ваш опыт и мнение по этому вопросу будут очень полезны для углубленного изучения темы.

Вы будете участвовать в обсуждении в фокус-группе, которое займет около 40 минут. Только ваш пол и предмет выбора (биология или физика) будут раскрыты в ходе анализа собранных данных. Всех участников попросят не идентифицировать себя и других, но есть риск нарушения конфиденциальности в групповой обстановке.


Любая информация, полученная в ходе этого исследования, будет оставаться конфиденциальной в максимально возможной степени. Будут предприняты все разумные усилия для сохранения конфиденциальности вашей личной информации в записях исследования, но полная конфиденциальность в групповой обстановке не может быть гарантирована. Всем участникам будут присвоены псевдонимы, и только исследователь будет иметь доступ к записям и собранным данным. Персональный компьютер исследователя будет защищен паролем. Собранные данные не будут использоваться для оценки вашей успеваемости в школе или для оценки системы. Ваше участие в этом исследовании является строго добровольным, и если дано согласие на участие, оно может быть отозвано в любое время без ущерба. Вы имеете право отказаться отвечать на конкретные вопросы.

Если вы хотите участвовать в данном исследовании или у вас есть какие-либо вопросы относительно этого проекта, пожалуйста, свяжитесь со мной по электронной почте или по номеру телефона, который написан ниже.

Электронная почта: akmaral.dauletiyarova@nu.edu.kz Номер телефона: +77074531050

Appendix D

Codes and their convergence into the main themes

Codes	Sub-themes	Salient themes
<ul style="list-style-type: none"> • relative ease of the subject • no need to memorize definitions • more opportunities/ grants with Physics • interestingness of the subject • good knowledge and skills • self-confidence in one's knowledge and skills in STEM • not very active in high school • no frequent discussions 		Student engagement in STEM subjects
<ul style="list-style-type: none"> • active participation in some topics • level/ skill dependence on topics • participation depends on topic • participation depends on the interest • participation depends on the relation to future studies • teachers' methodology, exposition, close monitoring of students' expressions to gauge their interest • preference for theories • preference for applied knowledge 		The fluidity of student engagement in STEM
<ul style="list-style-type: none"> • boys' participation in out of classroom activities • different level of engagement (boys are more active) • boys' high level of involvement • girls' lower level of involvement • lack of self-confidence (boys) • girls' higher competence • different way of perceiving information • different norms of behavior as a student • different way of doing tasks 		Gender and student engagement in STEM
<ul style="list-style-type: none"> • family influence in choosing physics for girls (family, husband) • fear of choosing technical specialties for girls • discrimination by gender • gender stereotypes • gender differences in choosing subjects 	Gendered cultural norms	Reasons for gender differences in student engagement in STEM
<ul style="list-style-type: none"> • girls are under pressure to comply to teachers' instructions; • higher expectations from girls to do homework • treating boys and girls differently (by teachers) 	Gendered classroom norms	
<ul style="list-style-type: none"> • has  relation to future profession • no relation with future profession • utility for future studies/career 	The perceived utility for	

<ul style="list-style-type: none">• choosing STEM-related fields (IT)• choosing non STEM-related careers (Economics, Tourism, International Relations, Finance)	future studies and career	
<ul style="list-style-type: none">• need for competitions• competition increases achievements and engagement• collaboration increases engagement and interest• more practical work• more physics problems• more laboratory experiments• effective use of problem-solving		Strategies that might enhance student engagement in STEM