Required and Acquired Skills in STEM: Comparing Employers and Graduates' Perceptions in Kazakhstan

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October 2019

Dear Yevgeniya

This letter now confirms that your research project entitled: Required and Acquired Skills in STEM: Comparing Employers and Graduates' Perceptions in Kazakhstan has been approved by the Graduate School of Education Ethics Committee of Nazarbayev University.

OR
The changes recommended by the reviewer have been addressed and the proposed study now complies with all of the requirements of Nazarbayev University.

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Yours sincerely

Dilrabo Jonbekova

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Abstract

Required and Acquired Skills in STEM: Comparing Employers and Graduates' Perceptions in Kazakhstan

University graduates' skill sets remain a highly debated topic in Kazakhstan. While universities are experiencing increasing pressure from employers and policy makers with regards to bringing their programs closer to market needs, little is known about graduates' required and acquired skills in Kazakhstan. This study addresses this gap by examining graduates and employers' perceptions about science, technology, mathematics and engineering (STEM) graduates' skill sets at one university in Kazakhstan. Using mixed methods research design, it aims to identify the most important skills for novice STEM professionals, to reveal how satisfied employers are with graduates' skill sets and how graduates themselves assess their skills attained at the university so as to contribute to a better understanding of the role of universities, employers and students in developing students' skills. The findings suggest that in addition to field-specific knowledge, generic skills are highly important for STEM graduates perceived by both graduates and employers. In particular, *ability to solve problems, working well in a team, ability to work under pressure, getting on well with others in the workplace,* and *ability to learn quickly* are found to be the most important skills for STEM graduates. The study revealed significant gaps between graduates' required and acquired skills. Graduates appeared to be mainly dissatisfied with their field-specific knowledge and skills, whereas employers see the biggest gaps in graduates' *ability to solve problems, capacity to work without close supervision, ability to work under pressure* and *getting on well with others in the workplace.* The findings show that university, student and employer are all active participants in the process of developing students' skills. Overall, this study enhances the

understanding of university graduates' skill sets in Kazakhstan and might help university authorities and STEM program coordinators to improve their degree programs.

Аннотация

Необходимые и Приобретенные Навыки в STEM: Сравнивая Мнения Работодателей и Выпускников в Казахстане

Навыки выпускников ВУЗов остаются широко обсуждаемой темой в Казахстане. В то время как университеты испытывают все большее давление со стороны работодателей и политиков в отношении приближения университетских программ к потребностям рынка, мало что известно о необходимых и приобретенных навыках выпускников в Казахстане. Данное исследование устраняет этот пробел, изучая мнения выпускников и работодателей о навыках выпускников в области науки, технологий, инженерии и математики (STEM) в одном университете Казахстана. Используя смешанный метод, данное исследование направлено на выявление наиболее важных навыков для начинающих профессионалов STEM, определение насколько работодатели довольны навыками выпускников, и как сами выпускники оценивают свои навыки, полученные в университете, чтобы способствовать лучшему пониманию какую роль играют университет, работодатель и студент в развитии навыков студентов. Полученные данные свидетельствуют о том, что в дополнение к профильным знаниям, общие или, так называемые, мягкие навыки очень важны для выпускников STEM, по мнению как выпускников, так и работодателей. В частности, *способность решать проблемы, хорошо работать в команде, способность работать в стрессовой обстановке, хорошо ладить с другими сотрудниками на рабочем месте,* и *способность быстро учиться* - самые важные навыки, необходимые выпускникам STEM для трудоустройства. Исследование выявило значительные различия между необходимыми и приобретенными навыками выпускников. Так, выпускники в основном недовольны своими знаниями и навыками в профильной для них области, тогда как работодатели

видят самые большие пробелы в способности выпускников *решать проблемы, работать без пристального контроля, работать в стрессовой обстановке* и *хорошо ладить с другими сотрудниками на рабочем месте*. Результаты показывают, что университет, студент и работодатель являются активными участниками процесса развития навыков студентов. В целом, данное исследование улучшает понимание подготовленности выпускников ВУЗов к рынку труда в Казахстане и может помочь руководству университетов и координаторам улучшить STEM программы.

Аңдатпа

Қазақстандағы Жұмыс Берушілер мен Түлектердің Пікірін Салыстырумен STEM Қажетті және Игерілген Дағдылар

Түлектердің дағдылары Қазақстанда кеңінен талқыланатын тақырып болып қала бермек. Университеттерге жұмыс берушілер мен саясаткерлердің тарапынан университеттік бағдарламаларды нарықтық қажеттіліктерге жақындатуға қатысты қысым күшейіп келе жатқан кезде, Қазақстанда түлектерге қажетті және университетте игерілген дағдылар туралы мәлімет аз. Осы зерттеу, осы олқылықты түлектер мен жұмыс берушілердің ғылым, технология, инженерия және математика (STEM) саласындағы университет түлектерінің дағдылары туралы пікірлерін Қазақстанның бір оқу орындарында зерттеу арқылы шешеді. Аралас зерттеу әдісін қолдана отырып, бұл зерттеу STEM бастаушы кәсіпқойлары үшін ең маңызды дағдыларды анықтауға, жұмыс берушілердің түлектердің дағдыларына қаншалықты қанағаттанатынын және университеттердің, жұмыс берушілер мен студенттердің рөлін жақсы түсіну үшін түлектердің университетте алған білімдерін қалай бағалайтындығын анықтауға және дағдыларын дамытуда бағытталған. Алынған мәліметтер STEM түлектер және сонымен бірге жұмыс берушілер үшін бейінді білімге қатысты қосымша басқа жалпы дағдылар өте маңызды екенін көрсетеді. Атап айтқанда, STEM түлектері жұмысқа орналасу үшін ең маңызды дағды: *проблемаларды шеше білу, топта жақсы жұмыс істеу, стресстік ортада жұмыс істеу, басқалармен жақсы қарым-қатынас жасау болып табылады* және *тез үйрену қабілеті*. Зерттеу түлектерге қажетті және игерілген дағдылардың арасындағы айтарлықтай айырмашылықтар бар екенін анықтады. Сонымен, түлектер көбінесе өздерін қызықтыратын саладағы білімі мен дағдыларына қанағаттанбайды, ал жұмыс берушілер түлектердің *проблемаларды шешуге, мұқият бақылаусыз жұмыс*

істеуге, стресстік жағдайларда жұмыс істеуге және жұмыс орнында басқалармен жақсы қарым-қатынаста болуға байланысты үлкен кемшіліктерді байқайды. Нәтижелер университет, студент және жұмыс беруші студенттердің дағдыларын дамыту процесінің белсенді қатысушылары екендігін көрсетеді. Жалпы алғанда, бұл зерттеу университет түлектерінің Қазақстанның еңбек нарығына дайындығын түсінуді жақсартады және университет басшылары мен үйлестірушілерге өздерінің STEM бағдарламаларын жетілдіруге көмектеседі.

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Chapter 1. Introduction

Statement of the Problem

In 2012, the first president of Kazakhstan Nursultan Nazarbayev set a goal to become one of the 30 most developed countries in the world by the year 2050 (Nazarbayev, 2012). In accordance with the Kazakhstan-2050 Strategy, Nation's plan "100 Concrete Steps to Implement Five Institutional Reforms" places great emphasis on the development of knowledge-based economy (Nazarbayev, 2015). The advancement of innovation sectors, such as digital technologies, smart manufacturing, big data, renewable energy, new materials, etc., is highly prioritized in the country. The Kazakhstan-2050 Strategy underlines the role of higher education in achieving the country's strategic goals - universities are expected to prepare qualified workforce with the skill sets required for the development of national economy (Nazarbayev, 2015). In particular, it is of significant importance to prepare skillful professionals in STEM fields - science, technology, engineering and mathematics. Thus in 2019, the government offered 53785 state grants for pursuing a degree in Kazakhstani higher education institutions, with more than a half of grants allocated for studying information technology, process manufacturing, construction, engineering, hard sciences, mathematics and statistics (Guzenkov, 2019). Also, efforts are being made by policy makers to bring higher education closer to market needs and the requirements of employers. In 2018, in State of the Nation Address, the first President of Kazakhstan Nursultan Nazarbayev emphasized that "the main criterion of a successful university is the employment of graduates and high-paid jobs" (Nazarbayev, 2018). The new State Program for the Development of Education and Science for 2020-2025 requires universities and colleges to update their educational programs in accordance with employers' needs (Ministry of Education and Science of Kazakhstan, 2019). Furthermore, several state programs highlight the importance of students' acquisition of in-

demand skills and close collaboration between universities and industries in order to prepare job ready graduates. In particular, the state program Digital Kazakhstan highlights the importance of university programs to keep up with the evolving industry requirements and suggests transforming the way digital sciences are taught at universities through engaging professionals into curricula design and teaching (the Government of the Republic of Kazakhstan, 2017). According to the program, specific attention should be paid to development of skills which are in demand on labor market, such as programming skills, data analysis, creative thinking, etc. State program of industrial-innovative development of Kazakhstan for 2020-2025 indicates that in order to prepare job ready graduates, universities should equip students with professional competencies in new areas such as development of new materials, artificial intelligence, bioengineering, digital technologies, etc. (the Government of the Republic of Kazakhstan, 2019). Also, the program points out that higher education needs to collaborate with employers in order to ensure graduates' success in the workplace. Hence, Kazakhstani universities are expected to equip students with the skill sets that are highly demanded on the labor market, so after graduation they are ready to contribute to the development of national economy.

However, while the governmental expenditure on state grants is significant and the importance of bringing educational programs closer to market needs is highlighted in state programs, graduates' skill sets remain to be a highly debated topic in Kazakhstan. In recent years, several media articles expressed great concern over the skills and work readiness of university graduates in diverse areas of business (Borisov, 2014; "Kadry Yest", 2018; Kazistayev, 2020; Pokidayev, 2020; Sadyk, 2017; Verzhbitskaya, 2018; Vychodchenko, 2015). Furthermore, Jonbekova (2020) suggests that young people in Kazakhstan and Tajikistan tend to see the purpose of pursuing higher education mainly in improving their

employment prospects and future economic benefits. The qualitative study shows that the youth's motivation to obtain diplomas is often explained not by the interest in acquiring new knowledge and skills but by the increasing qualification requirements set by employers (Jonbekova, 2020). Also, a study conducted by PwC and Forbes Kazakhstan revealed that among different business threats, including price volatility, technological changes, cyberattacs and others, deficit of qualified workforce concerns CEOs of Kazakhstani companies - 61participants - the most (Shaternikova, 2018). Importantly, in 2018, the national chamber of entrepreneurs of the Republic of Kazakhstan Atameken pointed out that Kazakhstani employers are rarely satisfied with skill sets of graduates and presented its own ranking of Kazakhstani universities' academic programs ("Reiting Vuzov", 2018). Overall, the first ranking revealed that the majority of academic programs, especially in STEM fields, have become outdated and poorly related to market needs ("Atameken Provyol Ocenku", 2018; Selezneva, 2018). Moreover, in 2019, the President of the country Kassym-Jomart Tokayev announced that in order to improve the quality of education, strict measures have to be implemented, and universities which do not show a decent employment rate (60%) must be closed (Tokayev, 2019). Therefore, concerns raised by policy makers and employers indicate that there is a gap between labour market's requirements and graduates' skill sets in Kazakhstan. However, it is still not clear which skills are essential for STEM graduates, and to what extent employers and graduates themselves are satisfied with the skills acquired at university, including generic skills, which are considered to be as important as technical skills nowadays (Tran, 2015; Succi & Canovi, 2019).

From what has been discussed above, one can see that Kazakhstani universities are experiencing significant pressure from employers and policy makers with regard to enhancing graduates' employability, therefore, understanding the gaps between employers' needs and

Kazakhstani university graduates' skill sets is crucial. While the issue of university graduates' skill sets has been researched globally, very few research studies devoted to this issue have been conducted in Kazakhstan. Thus, Dautbayeva (2015) analyzed important skills for Medical graduates and found that employers highly value generic skills. Pak, Nuguzhinov and Pak (2016) report that almost half of employers in technical field are not satisfied with university graduates' skills, however without specifying which ones are missing.

Thus, little is known about employers and graduates' perceptions of STEM graduates' required and acquired skills in Kazakhstan. Therefore this study addresses this gap by identifying the skills STEM university graduates must possess and by looking at how satisfied Kazakhstani employers are with graduates' skills and how graduates themselves assess their skills attained at university.

Purpose and Objectives of the Study

The purpose of this study is to explore graduates and employers' perceptions with regard to STEM graduates' skill sets at one Kazakhstani university. The specific purposes of this study are:

1. To identify the most important skills for STEM graduates in order to get employed;
2. To find out how satisfied employers are with the skills possessed by graduates and how graduates themselves assess their skills attained at university;
3. To reveal how graduates and employers perceive the role of universities, students, and employers in developing students' skills;

Research Questions

The following research questions guided this study:

1. What are the most important skills perceived by STEM graduates and those expected by employers?
2. To what extent are employers satisfied with skills possessed by graduates and how do graduates themselves assess their skills attained at university?
3. What are graduates and employers' perceptions of the role of universities, students and employers in developing students' skills?

This thesis argues that both graduates and employers place great emphasis on generic skills for STEM graduates to possess. In particular, *ability to solve problems, working well in a team, ability to work under pressure, getting on well with others in the workplace,* and *ability to learn quickly* were found to be the most essential skills. The findings also show that there is a room for improvement in STEM graduates' skill sets. Graduates appeared to be the least satisfied with their field-specific knowledge and skills, pointing out the inconsistencies in curricula, imbalance between theory and practice, and neglect of local market realities as the main causes of existing deficiencies. However, employers believe that the biggest gaps between required and acquired skills exist in *ability to solve problems, capacity to work without close supervision, ability to work under pressure* and *getting on well with others in the workplace,* indicating the differences between academic and work environments and lack of time students spend outside campus as underlying reasons. Furthermore, the findings show that both graduates and employers believe that development of students' skills is a shared responsibility, so universities, employers and students themselves play a significant role in this process.

Significance of the Study and Potential Benefits

This study is expected to enhance understanding of STEM graduates' skill sets in Kazakhstan by exploring the gaps between industry requirements and graduates' skills. The

study might help STEM program coordinators to improve their degree programs by identifying the skills needed for graduates to perform successfully in the workplace and existing deficiencies in graduates' skill sets indicated by employers and graduates. Furthermore, the findings of the study may help university authorities to gain more understanding of how employers and graduates perceive the role of university, student and employer in developing students' skills, and therefore strengthen the cooperation among all parties involved. The study also provides current students with information about the most in-demand skills for STEM professionals and might help them with preparing for future careers. The study is hoped to benefit its participants as graduates had a chance to reflect on their skill sets and career paths, and employers were able reflect on their job requirements. Thus, participation in this study might help graduates to upgrade their skills, and employers - to improve hiring practices and provide better support for their employees who recently graduated from universities.

Outline of the Study

This thesis consists of six chapters: introduction, literature review, methodology, findings, discussion, and conclusion. The introduction part, which explains the rationale for conducting this research, its purpose and research questions, is followed by literature review where I discuss prior research studies into university STEM graduates' skill sets. The methodology section deals with the research design, sample characteristics and ethical considerations. The findings chapter discusses the key findings of this study. The discussion chapter analyzes the findings in relation to other studies into STEM graduates' skill sets. The conclusive part deals with practical implications of this study and provides thoughts for further research.

Chapter 2. Literature Review

This section presents the analysis of recent studies into science, technology, engineering and mathematics graduates' skill sets and explains the concepts used in this study. It discusses the most in-demand skills for professionals in STEM fields, the existing gaps between industry requirements and graduates' skill sets, and the role of universities, students and employers in developing students' skills.

Introduction

One of the main roles which higher education institutions play in society is producing qualified labor force. Globally, universities are expected to equip students with knowledge and skills relevant for the market, so after graduation they are ready to get employed and start contributing to the development of national economy. Due to globalization, unstable economic situation and technological advancement, labour market is constantly changing and so are skill sets required by employers (Griffiths, Inman, Rojas & Williams, 2018; Harvey, 2000; Heckman & Kautz, 2012; OECD, 2017). Although higher education institutions seem to make considerable efforts to establish partnership with employers through introducing work-integrated learning (Sin & Neave, 2016), transition to a workplace tends to be stressful for both graduates and employers due to the fact that knowledge and skills acquired at universities do not always match industry requirements (Ramadi, Ramadi, & Nasr, 2016; Peng, Zhang, & Gu, 2016).

Conceptualization of Graduate Employability and Skills Typology

The review of literature shows that there are different ways of defining employability. Hillage and Pollard (1998) define employability as "the capability to move self-sufficiently within the labour market to realize potential through sustainable employment" (p. 2). Hinchcliffe (as cited in Dacre Pool & Sewell, 2007) highlights the role of professional success,

meaning that a person does not only obtain and keep employment but becomes successful in the chosen profession. Furthermore, Dacre Pool and Sewell (2007) extended the definition by Hinchcliffe by adding job satisfaction as another important element of employability, so they refer to employability as "having a set of skills, knowledge, understanding and personal attributes that make a person more likely to choose and secure occupations in which they can be satisfied and successful" (p. 280). Recent definition by Small, Shacklock and Marchant (2018) highlights the responsibility of individuals for their employability, stating that employability is "the capacity to be self-reliant in navigating the labour market, utilizing knowledge, individual skills and attributes, and adapting them to the employment context, showcasing them to employers, while taking into account external and other constraints" (p. 151). While numerous definitions exist, analysis of literature shows that there is a common agreement among researchers that employability should not be limited to merely obtaining a job after graduation as it remains important throughout one's career.

Several scholars have attempted to create a model of graduate employability. Law and Watts (1977) proposed a DOTS-model which comprises decision learning, opportunity awareness, transition learning and self-awareness. Hillage and Pollard (1998) outlined four factors which influence individual employability such as possession of knowledge, skills and attributes, possession of career management skills, ability demonstrate the assets to employers, and external factors, such as market trends or personal circumstances. Yorke and Knight (2004) developed a USEM model which constitutes understanding, skills, efficacy beliefs and metacognition. CareerEDGE by Dacre Pool and Sewell (2007) includes career development learning, experience, degree subject knowledge, understanding and skills.

In recent years a skill-based approach toward analyzing the phenomenon of employability has been criticized. Holmes (2013) argues that obtaining certain skills is not

enough, and university graduates have to be able to present themselves on the labour market. The author believes that it is crucial for university students to develop a graduate identity, which means to be able to act as a graduate and to persuade employers that they are suitable candidates for a job. Similarly, Hincliffe and Jolly (2011) suggest that attributes and skills should be analyzed along with graduate experiences. They propose that graduate identity comprises values, intellectual abilities (including critical thinking and creativity), engagement, and performance, e.g. ability to apply skills and knowledge to work (Hincliffe & Jolly, 2011). Clarke (2018) argues that in addition to skills and knowledge, it is reasonable to discuss labour market characteristics, individual traits, personality, and perceived employability. Overall, employability constitutes a complex combination of factors, both internal and external. However, all existing models include knowledge and skills as essential elements of graduate employability.

Literature shows that there is no universal typology of skills. However, generally, scholars divide skills into groups such as *field-specific* and *generic* skills. Thus, Becker (1993) and Stevens (1994) differentiate between firm-specific and general or transferrable knowledge and skills. On the other hand, Bunk (1994) proposes four types of skills such as specialized, methodological, participative, and socio-individual skills. Hernandez-March, del Peso and Leguey (2009) discuss vocational and generic types which include knowledge-related, methodological and interpersonal skills. Similarly, Kohler (2004) divides skills into technical and soft skills (knowledge-related, methodological, personal and social).

Field-specific skills, also called “hard” or vocational skills, are related to a specific degree. Dacre Pool and Sewell (2007) argue that vocational skills play a defining role in obtaining a job as employers firstly evaluate subject specific skills and only after that pay attention to generic ones. Generic skills, on the other hand, can be easily transferred and

applied to different occupations and job tasks. Scholars seem to use terms *generic, core, personal, soft, transferable* and *life skills* interchangeably (Holmes, 2013; Succi & Canovi, 2019). For example, Moore and Morton (2017) discuss 'twenty-first century skills', OECD (2017) highlight 'transformative competencies', while World Economic Forum refers to 'human skills' (WEF, 2018). Heckman and Kautz (2012) refer to soft skills as "personality traits, goals, motivations and preferences that are valued in the labor market, in school, and in many other domains" (p. 2).

Throughout the thesis, I will use the terms field-specific knowledge and skills and generic skills. For the purpose of this study, I will use the following definition of generic skills proposed by Haselberg within the ModEs project (as cited in Succi & Canovi, 2019) which states that generic skills "represent a dynamic combination of cognitive and meta-cognitive skills, interpersonal, intellectual and practical skills" (p. 2).

Overall, the analysis of literature shows that employability is a multidimensional concept, and both field-specific and generic skills play an important role in obtaining employment and performing successfully in the workplace.

Graduate Employability and Skills Development in Kazakhstani Context

In Soviet period, higher education system was designed to prepare workforce specifically for the needs of planned economy. Labour market was regulated through the job placement system, so all career paths in the country, starting from the first employment till the retirement, were navigated not by the employees themselves but by the government (Kotliar, 1984).

After gaining its independence in 1991, Kazakhstan changed its course from planned to market economy. The Kazakhstan-2030 Strategy, which was announced in 1997 by the first president of Kazakhstan, indicates economic growth through development of free market

economy as one of the country's key priorities (Nazarbayev, 1997). However, the system of higher education was poorly prepared for such radical changes as Kazakhstan inherited Soviet system which was highly specialized and relied on planned economy and stable job market. Soviet universities had to prepare students for specific roles and organized special committees which were responsible for finding a suitable position for each graduate (De Witt, 1961). In other words, after receiving diplomas all graduates were guaranteed a job in accordance with their degree. Transition from planned to free market economy required changes in this approach to higher education and its relationship with labour market. Students were no longer guaranteed a job after graduation and became responsible for their future careers. However, universities kept following the Soviet system for a long time, and only in 2010, when Kazakhstan joined the Bologna process, higher education system saw changes with regards to academic programs, assessment system, and other areas. The most recent strategic plan of Ministry of Education and Science of Kazakhstan for 2017-2021 indicates preparing employable specialists in accordance with the needs of labour market as one of the main strategic directions in developing higher education (Ministry of Education and Science of Kazakhstan, 2016). In recent years, in order to improve higher education system and upgrade human capital of the country, policymakers have implemented variety of measures, including the extension of academic autonomy of Kazakhtani universities. Before this reform Kazakhstani universities had to follow state plans, but now they are able to make changes to their programs so as to equip students with up-to-date knowledge and skills.

There has been little research into university graduates' work readiness in Kazakhstan. Pak et al. (2016) argue that while there have been positive changes in bringing Kazakhstani higher education closer to industry needs, the level of cooperation between universities and employers still remains to be significantly low. The survey among 243 representatives of

metallurgy, construction and mechanical engineering industries from Karaganda region (Central Kazakhstan) reveled that employers are not ready to take part in creating academic programs. The main reasons are lack of resources, outdated technologies and equipment, and limited opportunities of implementing innovations in the near future (Pak et al., 2016). In other words, employers do not see how recent university graduates, whose minds tend to be full of new approaches and innovative ideas, can be integrated into the industry with Soviet legacy. Thus, one third of the participants are not interested in hiring fresh graduates without working experience (Pak et al., 2016). Furthermore, the study reports that around 40% of respondents state that graduates lack practical skills and competencies, whereas for 30% of respondents it seems to be difficult to even identify the requirements. It is consistent with OECD report which recommends Kazakhstan to strengthen relationship between universities and employers and create a system of information which reflects graduates' labour market outcomes (OECD, 2017). Dautbayeva (2015) analyzed employers' requirements toward medical students in Semei (East Kazakhstan) and proposed a model for enhancing graduates' employability which engages university authorities, employers, policymakers and recruiting agencies. The quantitative study showed that employers value soft skills more than moral traits and theoretical knowledge. The most important skills include critical thinking, leadership, clinical skills, interpersonal skills, knowledge of laws and ethical norms, and willingness to learn.

Overall, while higher education in Kazakhstan is highly affected by Soviet period, nowadays it is evolving and introducing international standards of education with special attention paid to students' skill cultivation in accordance with market needs. However, it is still not clear how international approaches and Soviet industrial legacy can coexist.

Perceived Importance of Skills in STEM Disciplines

Globally, efforts have been made to identify the most important skills for STEM graduates to possess in order to succeed in the workplace. Literature demonstrates the increasing importance of generics skills for university graduates due to globalization and constantly changing market needs (Crebert, Bates, Bell, Patrick, & Cragnolini, 2004; Farr & Brazil, 2009; Laker & Powell, 2011). Harvey (2000) argues that generic skills are helpful for integrating into organization culture, thus necessary for successful transition from university to the labour market. Moreover, Goleman (1995) argues that emotional intelligence, e.g. ability to recognize own and other people's emotions and act accordingly, is a predictor of successful career. A survey conducted across the US employers revealed that generic skills are considered to be more important than field-specific ones for entry-level information system professionals (Jones, Leonard, & Lang, 2018). It is consistent with a research devoted to skills required for big data professionals – a content analysis of job advertisements on one global website showed that generic skills remain crucial for employers (Gardiner, Aasheim, Rutner, & Williams, 2018). Peng et al. (2016) surveyed Chinese employers, alumni and graduates and found that the competency of communication and cooperation is considered to the most important for Master of Engineering graduates among all groups of respondents. In Malaysia, Cheong, Hill, Leong and Zhang (2018) showed that students' perceptions are in line with employers with regard to the importance of generic skills over technical knowledge. However, employers and graduates are not always in agreement with regard to the most important skills. Thus, in the UK, Saunders and Zuzel (2010) found that while employers prioritize personal qualities and generic skills, bioscience graduates and students tend to place more importance on technical knowledge.

Generally, communication and teamwork skills seem to be the most valuable assets for STEM graduates. In Australia, employers perceive communication and teamwork skills to be essential for novice engineers (Nair, Patil, & Mertova, 2009). Also, the study based in the Middle East and North Africa region showed similar results - communication and cooperation skills of engineering graduates are highly valuable by managers (Ramadi, et al., 2016). Along with communication skills, ability to solve problems was found to be highly valued by American employers with regard to engineering graduates (Lattuca, Terenzini, & Volkwein, 2006). Other important skills include ability to use modern technology and ability to apply field-specific knowledge and skills to job tasks (Lattuca et al., 2006).

Ability to acquire new knowledge and skills is also believed to play an important role in STEM graduates' career. Coll and Zegwaard (2006) identified key competencies for science and technology graduates by surveying students, alumni, employers and faculty in New Zealand. The results showed that the most valued skill among all groups of respondents was ability and willingness to gain new knowledge. Similarly, willingness to learn was indicated as an important skill for information technology professionals in the USA (Jones et al., 2018). A survey conducted among bioscience students, graduates and employers revealed that all groups value enthusiasm and willingness to learn (Saunders & Zuzel, 2010). Ability to learn is also highly valued by employers in the engineering area (Nair et al., 2009). Guest (2006) stressed that the importance of lifelong learning, pointing out that modern engineers are expected to be able to constantly develop throughout their career. Additionally, Farr and Brazil (2009) suggest that leadership skills are of significant importance for American engineers as they help professionals to adjust to constantly changing global markets.

On the other hand, it is generally agreed that management skills are not as important as other skills for university graduates. Peng et al. (2016) state that all informants, namely

graduate students, alumni and employers perceive organization management as not important competency for novice engineers in China. It is consistent with the study conducted among Australian employers in the engineering area (Nair et al., 2009).

To summarize, employers and graduates seem to highly value generic skills, especially communication and teamwork skills. While it does not mean that employers and graduates do not pay attention to field-specific knowledge, it indicates that generic skills play an important role in STEM graduates' work readiness and that acquisition of only field-specific knowledge is not enough nowadays. Furthermore, it should be noted that employers and graduates' perceptions with regard to the important skills do not always coincide.

Gaps between Required and Acquired Skills in STEM

In attempting to provide better understanding of how well universities prepare students for future career, educational researchers often investigate the existence of gaps between industry requirements and graduates' skill sets. The literature shows that findings of such studies tend to vary to a great extent with regard to both field-specific and generic skills.

Several scholars found the mismatch between industry needs and graduates' field-specific knowledge and skills. Thus, subject knowledge and ability to apply it to job tasks was named as one of the most needing improvement by Malaysian employers from diverse areas (Cheong et al., 2016). Also, Indian employers appeared to be dissatisfied with engineering graduates' technical skills (Blom & Saeki, 2011). On the other hand, in Australia, the smallest gaps between industry requirements and engineering graduates' skill sets were found in the areas of field-specific knowledge and skills and usage of communication technology, meaning that employers are quite satisfied with these skills (Nair et al., 2009). Similarly, study based in the US, revealed that employers were also quite satisfied with engineering graduates' technical skills (Lattuca et al., 2006). Also, the study based in the Middle East and North Africa

(MENA) region showed that employers are most satisfied with engineering graduates' ability to use modern technology and ability to apply mathematical knowledge (Ramadi, et al., 2016).

With regards to generic skills, several studies show that employers are quite dissatisfied with engineering graduates' communication skills, ability to manage time and learning skills. Thus, managers in MENA region are not satisfied with communication skills of engineering graduates and believe that this competency should be enhanced along with time management and continuous learning (Ramadi, et al., 2016). In other words, employers in MENA region believe that engineering graduates need to improve both written and oral communication skills, plan their time more effectively, and be more responsible for their professional development (Ramadi, et al., 2016). Very similarly, a study conducted in Australia showed that there are gaps in employers' expectations and engineering graduates' skills with regard to time management, communication skills, ability to set learning goals, and leaderships skills (Nair et al., 2009). Bodmer, Leu, Mira, & Rütter (2002) surveyed academics, engineers, human resource professionals and line managers based in the USA and Europe and found that engineering graduates lack communication, teamwork and leadership skills. Also, Peng et al. (2016) report that Chinese students, alumni and employers believe that communication and cooperation skills of novice engineers need to be urgently improved. Employers also express dissatisfaction with engineering graduates' problem-solving skills in India and Australia (Blom & Saeki, 2011; Nair et al., 2009). On the other hand, American employers were found to be quite satisfied with engineering graduates' ability to learn and grow professionally (Lattuca et al., 2006). These findings parallel the perceptions of Indian employers, who are also satisfied with engineering graduates ability to communicate effectively (Blom & Saeki, 2011). Ashman, Scrutton, Stringer, Mullinger and Willison.

(2008) found that both Australian employers and chemical engineering graduates believe that graduates are best-equipped with teamwork skills.

It is worth noting that employers and graduates' perceptions do not always match. In this regard, Peng et al. (2016) report that while Chinese employers are satisfied with field-specific skills of engineering graduates, students and graduates themselves feel that these skills have to be improved. A quantitative study conducted in Australia reveled skill mismatch between industry needs and chemical engineering graduates (Ashman et al., 2008). Employers believe that there is a need to improve graduates' communication skills, whereas graduates perceive their communication skills to be well-developed.

Overall, globally graduates' skills do not always match employer requirements with regard to both field-specific and generic skills. Moreover, graduates themselves appear not to be satisfied with the skills acquired at university.

The Role of Universities, Employers and Students in Developing Students' Skills

There are continuous debates among scholars about who is responsible for universities graduates' employability. Tran (2015) argues that universities cannot be perceived as the only stakeholder responsible for graduate employability. The qualitative research conducted among Vietnamese students, graduates and employers representing diverse disciplines and industries, revealed misunderstanding and poor cooperation between HEIs and other stakeholders (Tran, 2015). Although employers tend to value work-related experience most while recruiting university graduates, they acknowledge low level of engagement in collaborating with universities from their side. They might be reluctant to provide students with internships or support them while they are interns. On the other hand, while students blame universities for poor generic skills development, they still admit that when it comes to participation in classroom or extracurricular activities they might be passive and therefore lose opportunities

to acquire new knowledge and improve their skills. Similarly, a study based in Portugal revealed low level of cooperation between higher education institutions and employers (Sin & Amaral, 2017). A survey among 64 employers and 684 academics showed that universities are perceived to be the main site of developing students' employability by both groups of respondents. However, it is important to notice that academics placed almost equal responsibility for their employability on students. Employers and policy makers are perceived to be less responsible for students' employability by both employers and academics. With regards to employers' participation in institutional activities, it remains significantly low with only exceptions of internships and students' visits to organizations. However, Tholen (2019) suggests that both graduates and employers acknowledge the limitations of universities in terms of skills formation and therefore do not expect them to be the only place where skills, both hard and soft ones, can be acquired. In-depth interviews with laboratory scientists, software engineers, financial analysts and press officers based in the UK revealed a number of factors which do not allow universities to teach all skills essential for future jobs. Some universities cannot provide students with modern technology and laboratory equipment due to their high costs. Both employers and employees emphasized the importance of work-based learning; graduates are expected to continue developing and mastering their skills while working on real projects. The participants also mentioned that individuals should be responsible for their professional development and employability. It is also problematic to create one curriculum which will meet the needs of every organization as they have unique structures, way of working and corporate culture (Holmes, 2013).

Based on the above analysis, it is clear that the role of universities in developing graduate employability remains under-explored. While some studies show that higher

education system is expected to equip students with relevant knowledge and skills which are in line with industry needs, the responsibility of students and employers cannot be neglected.

Enhancing students' employability remains a highly debated topic on national political agendas. Due to massification of higher education and high competiveness of labour market, a university diploma does not guarantee employment in the future (Holmes, 2013; Tomlinson, 2012). It has been argued that nowadays in globalized and economically uncertain world university graduates have to be flexible and adaptable in order to stay relevant on the employment market (Bridgstock, 2009). Employers expect university graduates to possess not only technical knowledge related to their specialty but also a wide range of generic skills (Andrews & Higson, 2008). However, a large body of studies shows that employers are not satisfied with graduates' skill sets and overall work readiness. Heavy governmental investment in higher education forces policymakers to require measurable results such as high employment rate and businesses' satisfaction. One of the main causes of skill and knowledge deficiencies is poor communication between stakeholders, namely university, student, and employer.

Chapter 3. Methodology

This chapter presents the methodology of the study. It discusses the research design, sampling strategy, methods and procedures of data collection, and data analysis. Ethical considerations are described at the end of the chapter along with the procedures to minimize potential risks.

Research Design

This study employs a convergent mixed method research design which means that quantitative and qualitative data was collected and analyzed independently, and then the results of two datasets were converged (Cresswell & Plano Clark, 2018). Thus, in order to answer all research questions of this study, both quantitative and qualitative data was collected: an online survey with employers and graduates was used to collect quantitative data, whereas in-depth semi-structured interviews with a smaller sample of graduates and employers were employed for collecting qualitative data (figure 1).

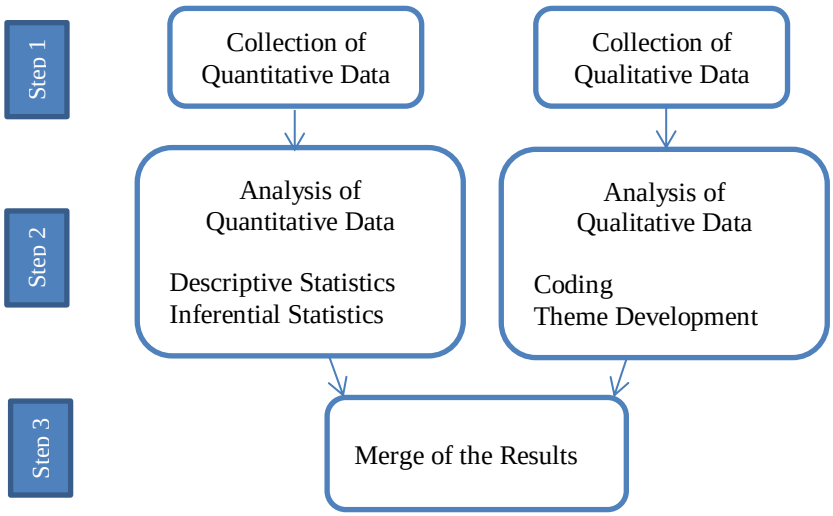

Figure 1. Research Design of the Study

Additionally, a case study design was opted for as this study as it focuses on employers and graduates of one university and aims to go into detail for exploring the research problem. Yin (2018) pointed out that case studies make it possible "to focus in-depth on a 'case' and to retain a holistic and real-world perspective" (p. 4).

The choice of using mixed method design in based on the need of creating a comprehensive understanding of the researched problem (Cresswell & Plano Clark, 2018; Teddlie & Tashakkori, 2009). A single approach alone would not work well for this study as it would provide very limited, incomplete understanding of the problem. Thus, if only quantitative data had been collected, there would have been no explanation of the survey's results, in particular, why some skills are believed to be important, what cause deficiencies in graduates' skill sets, and how the roles of different stakeholders in students' development are perceived by participants. Also, there would be no personal experiences of the participants regarding the acquisition and application of knowledge and skills to job tasks which provide useful insights and enrich the study. On the other hand, if only qualitative data had been collected, the results would have lacked general understanding of the researched case, so it would not have been possible to see a broad picture of graduates and employers' perceptions. Teddlie and Tashakkori (2009) highlight that "one type of data gives greater depth, whereas the other gives greater breadth; together it is hoped that they yield results from which one can make better (more accurate) inferences" (p. 38). Therefore, in this study, for all research questions, an online survey has been employed to see a big picture of graduates and employers' perspectives on graduates' skills, whereas in-depth interviews allowed the researcher to gain insight into the problem through participants' personal experiences and subjective opinions.

Furthermore, mixed method research design is considered to be an effective approach for conducting case studies as it allows exploring the case in a great depth (Cresswell & Plano Clark, 2018). Bazeley (2018) discusses case studies as one of the 'inherently mixed strategies' in which researchers use the advantages of both methods to strengthen their studies. As the data for this study was collected at one point in time, this study is cross-sectional (Creswell & Creswell, 2018).

Sample

The population of this study comprises of science, technology, engineering and mathematics graduates with a Bachelor's degree from one university in Central Kazakhstan received in 2016, 2017 or 2018, and their employers representing diverse industries, such as oil and gas, mining, construction, finance, education, etc.

The university, which has been chosen for data collection, is located in Central Kazakhstan and considered to be one of the leading higher education institutions in the country. It aims to become internationally recognized university and prepare highly skilled graduates who will contribute to further development of Kazakhstan. It receives large donations from the government and expected to be a model for other universities in the country through sharing its best practices in using innovative research, teaching, and management methods. The language of instruction is English, and faculty are mainly foreign professionals. Also, the university pays specific attention to the development of research.

In case of university graduates, to collect quantitative data, total population sampling, which is also called saturation sampling, was employed for this study. Saturation sampling is usually used when specific universities, businesses or non-profit organizations are studied, so all members of the population can be easily identified and reached (Sue & Ritter, 2007). As the target population of this study, e.g. STEM graduates of one university, is known and

reachable, saturation sampling has been chosen for this study. A sampling frame, the list of STEM graduates and their email addresses, was readily available and obtained through the Career and Advising Center of the chosen university. Thus all graduates who received a Bachelor's degree in biological sciences, chemistry, computer science, mathematics, robotics and mechatronics, mechanical engineering, chemical engineering, civil engineering, electrical and electronic engineering, or physics from the chosen university in 2016, 2017 or 2018 were invited to participate in the study. The researched period is limited to three cohorts (2016, 2017 and 2018) due to the fact that participants might not clearly remember their perceptions from earlier periods (Ramadi, et al., 2016). Besides, graduates of 2019 were purposefully excluded from the sample as they did not have enough time to get exposed to diverse job tasks, and at the same time they might have experienced stress while transiting from a university to workplace, so their perceptions might be heavily affected by this fact.

The choice of employer-participants was limited due to the unavailability of sampling frames. While choosing participants on non-probability basis is less preferable for quantitative studies than probability sampling, it is still often used by researchers when it is difficult or impossible to select potential participants (Sue & Ritter, 2007). In this study, the target employer-population – directors, line managers, supervisors or human resources professionals with experience of working with STEM graduates from the chosen university – was difficult to identify, therefore convenience sampling has been employed. This fact was taken into account when making conclusions and is further discussed in the limitations of the study. Contacts of the companies were obtained through the Career and Advising Center of the chosen university, so human resources (HR) departments of these companies were sent invitation to participate in the study and to share the link within their organizations. Only those companies which have hired at least one STEM graduate in the past three years were invited to

take part in the study. Employers who were invited to participate in the study operate in Kazakhstan and represent diverse industries, including construction, energy, telecommunications, oil and gas, education, etc. The recruitment letter asks directors, line managers, supervisors of graduates or human resources professionals who have experience of working with or hiring graduates from the chosen university to complete the questionnaire.

A total of 935 STEM graduates and 40 employers were asked to participate in an online survey. The survey produced 206 responses, among which 187 were received from university graduates and 19 from employers, so a 21.13% response rate was obtained. 11 responses were excluded from the analysis as they were found to be incomplete, so finally 176 responses from university graduates and 19 from employers were analyzed for this study. Table 1 lists the major characteristics of the university graduates participating in the study.

University graduates received a Bachelors' degree from the chosen university in 2016 - 45 respondents (25.6%), in 2017 – 86 respondents (48.9%), or in 2018 - 45 respondents (25.6%). Overall, 47 (26.7%) were females and 129 (73.3%) were males. With regards to academics majors, 20 respondents (11.4%) studied biological sciences, six (3.4%) - chemistry, 16 (19.1%) - computer science, 21 (11.9%) - mathematics, 12 (16.8%) - robotics and mechatronics, 18 (10.2%) - mechanical engineering, 27 (15.3%) - chemical engineering, 21 (11.9%) - civil engineering, 35 (19.9%) - electrical and electronic engineering. Graduates who received a degree in physics were also invited to participate in the study. However, no responses were received. This fact is further discussed in the limitations of the study. The large majority of the respondents, 123 people (69.9%), are full-time employed, followed by 36 respondents (20.5%) who are currently pursuing further education.

Table 1

Profile of Online Survey Participants: University Graduates

Variable	N	%
Year of graduation:		
2016	45	25.6
2017	86	48.9
2018	45	25.6
Gender:		
Male	129	73.3
Female	47	26.7
Academic major:		
Biological Sciences	20	11.4
Chemical Engineering	27	15.3
Chemistry	6	3.4
Civil Engineering	21	11.9
Computer Science	16	9.1
Electrical and Electronic Engineering	35	19.9
Mathematics	21	11.9
Mechanical Engineering	18	10.2
Robotics and Mechatronics	12	6.8
Employment status:		
Full-time employed	123	69.9
Part-time employed	7	4.0
Self-employed	4	2.3
Not employed; looking for a job	4	2.3
Not employed; not looking for a job	2	1.1
Pursuing further education	36	20.5
Industry		
Consulting	6	3.4
Construction	12	6.8
Education & Science	14	8.0
Energy	6	3.4
Finance	7	4.0
Information Technologies	27	15.3
Healthcare	2	1.1
Manufacturing & Production	4	2.3
Mining & Oil and Gas	38	21.6
Telecommunications	3	1.7
Transportation	2	1.1
Other	9	5.1

The minority of the respondents are part-time employed (seven respondents or 4%) or self-employed (four respondents or 2.3%), or not working at the moment of completing the survey (six respondents or 3.4%, including both who are looking and not looking for a job). Among those respondents who are employed, 38 graduates (21.6%) represent mining or oil and gas industries, 27 graduates (15.3%) - information technology, 14 (8%) graduates - education and science, 12 graduates (6.8%) – construction, and nine (5.1) - other industries.

For further analysis and interpretation of the results, it is also important to look at how graduates' majors, current employment status and industry relate to each other. Thus table 2 present the results of crosstabulation analysis by major and employment status of graduates.

Table 2

The Results of Crosstabulation Analysis by Graduates' Major and Employment Status

		What is your current employment status?						
		Full-time employed	Part-time employed	Self-employed	Not employed; looking for a job	Not employed; not looking for a job	Pursuing further education	Total
What was your major?	Biological Sciences	9	1	0	1	0	9	20
	Chemical Engineering	23	1	0	0	1	2	27
	Chemistry	2	1	0	0	1	2	6
	Civil Engineering	15	0	2	0	0	4	21
	Computer Science	13	0	0	0	0	3	16
	Electrical and Electronic Engineering	25	1	1	0	0	8	35
	Mathematics	14	3	1	0	0	3	21
	Mechanical Engineering	15	0	0	1	0	2	18
	Robotics and Mechatronics	7	0	0	2	0	3	12
Total		123	7	4	4	2	36	176

Table 3 present the results of crosstabs analysis by major and industry of graduates.

Table 3

The Results of Crosstabulation Analysis by Graduates' Major and Industry

		What industry do you work in?												
		Consulting	Construction	Education & Science	Energy	Finance	Information Technologies	Healthcare	Manufacturing &	Mining & Oil and Gas	Telecommunications	Transportation	Other	Total
What was your major?	Biological Sciences	0	1	7	0	0	0	2	0	0	0	0	0	10
	Chemical Engineering	2	0	1	2	0	1	0	2	14	0	0	1	23
	Chemistry	0	0	1	0	0	0	0	0	2	0	0	0	3
	Civil Engineering	0	7	0	1	0	0	0	0	6	0	1	1	16
	Computer Science	0	0	0	0	0	10	0	0	1	1	0	1	13
	Electrical and Electronic Engineering	0	1	1	3	1	9	0	1	7	1	0	2	26
	Mathematics	2	1	4	0	6	2	0	0	0	0	0	3	18
	Mechanical Engineering	2	2	0	0	0	1	0	1	8	0	1	0	15
	Robotics and Mechatronics	0	0	0	0	0	4	0	0	0	1	0	1	6
	Total	6	12	14	6	7	27	2	4	38	3	2	9	130

It can be observed that the majority of those who studied biological sciences currently work in the field of education and science (seven respondents); chemical engineering graduates mainly work mining or oil and gas industry (14 respondents) as well as mechanical engineering (eight respondents); majority of civil engineering graduates represent construction (seven respondents) or mining or oil and gas industry (six respondents); computer science graduates mainly work in IT industry (10 respondents) and robotics and mechatronics (four respondents); electrical and electronic engineering work in IT (nine respondents) or mining or oil and gas industries (seven respondents), those who studied mathematics work in the field of

finance (six respondents) or education and science (four respondents), whereas chemistry graduates mainly work in mining or oil and gas industry (two respondents).

Table 4 presents the characteristics of the employers.

Table 4

Profile of Online Survey Participants: Employers

Variable	N	%
Industry		
Consulting	2	10.5
Construction	2	10.5
Education & Science	2	10.5
Finance	2	10.5
Information Technology	2	10.5
Manufacturing & Production	2	10.5
Mining & Oil and Gas	6	31.6
Transportation	1	5.3
Company size		
100-499	4	21.1
500-999	4	21.1
1000 and more	11	57.9
Company ownership		
Public	3	15.8
Private	10	52.6
Other	6	31.6

Employers participating in the study represent the following industries: six participants (31.6%) work in mining or oil and gas industries, two participants (10.5%) in manufacturing and production, two participants (10.5%) in finance, two participants (10.5%) in information technology, two participants (10.5%) in education and science, two participants (10.5%) in construction, two participants (10.5%) in consulting, and one participant (5.3%) in transportation. Majority of the employer-respondents, 11 participants (57.9%), work in large companies with 1000 and more employees. Others represent smaller companies: four

participants (21.1%) – companies with 500-999 employees and four participants (21.1%) - companies with 100-499 employees. Regarding the ownership of the companies, the majority of the respondents – 10 respondents (52.6%) - work for private companies. Others represent public organizations - three participants (15.8%) or other forms of ownership - six participants (31.6%).

To collect qualitative data, survey participants were asked to take part in follow-up individual in-depth interviews (an invitation was incorporated into the online questionnaire). Thus, nine graduates and three employers from those who agreed to participate in follow-up interviews were selected using purposive maximal variation sampling. The main criterion for selecting participants for interviews was their experience with the researched problem, so they can share insight into graduates' skills and job readiness (Creswell, 2012). Additionally, as this study focuses on diverse STEM disciplines, it was important to interview graduates of different majors and employers from different fields to bring diverse perspectives to the research (Creswell, 2012). Table 5 presents the characteristics of graduates who participated in interviews.

University graduates participating in in-depth interviews are full-time employed and represent diverse majors. The sample includes both male and female graduates. Roughly half of participants currently work in Kazakhstan, whereas the other half works abroad. All interview participants are working by profession; except for one participant who has changed specialization but still have substantial experience of working in the area related to the Bachelor's degree. Thus, interview participants are able to share insight into graduates' preparedness for labor market, as their job duties are connected with the skills obtained at university.

Table 5

Profile of Interview Participants: University Graduates

Participant number	Gender	Major	Year of graduation	Employment status	Location
Graduate participant 1	Male	Chemical Engineering	2017	Project manager	Kazakhstan
Graduate participant 2	Male	Mechanical Engineering	2017	Mechanical engineer	Abroad
Graduate participant 3	Female	Biological Science	2016	Scientific worker at a laboratory	Kazakhstan
Graduate participant 4	Male	Civil Engineering	2016	Civil structure engineer at a construction company	Kazakhstan
Graduate participant 5	Male	Electrical and Electronic Engineering	2016	Engineer at a scientific laboratory	Kazakhstan
Graduate participant 6	Male	Chemical Engineering	2017	Process engineer at a construction company (mining)	Kazakhstan
Graduate participant 7	Female	Computer Science	2018	Developer at an IT company	Abroad
Graduate participant 8	Male	Electrical and Electronic Engineering	2017	Engineer at an oil and gas company	Abroad
Graduate participant 9	Male	Civil Engineering	2016	Engineer at a construction company	Abroad

Employers participating in the study have substantial experience in hiring recent graduates from the chosen university, represent construction, engineering and oil and gas industries and operate in Kazakhstan (Table 6).

Table 6

Profile of Interview Participants: Employers

Participant number	Industry	Position	Location
Employer participant 1	Construction & Engineering (industrial purposes)	Human Resources Manager	Kazakhstan
Employer participant 2	Construction	Human Resources Manager	Kazakhstan
Employer participant 3	Oil and gas	Human Resources Manager	Kazakhstan

Methods of Data Collection

The research instrument of the quantitative part of this study is an online questionnaire. Online format has been chosen purposefully due to the geographic diversity of the sample (Sue & Ritter, 2007). In other words, an online questionnaire seems to be the most convenient and cost-effective form of data collection for this study due to the fact that graduates and employers, the target population of the study, might live, study and work in different cities or countries.

The online questionnaire consists of four sections. The first section investigates the perceived importance of skills for STEM graduates to get employed. The participants were asked to rate the importance of skills using a five-point Likert Scale, where 1= not important, 2= of little importance, 3= neutral, 4= important, 5= very important. A list of 18 skills, which includes both field-specific and generic skills, has been compiled based on the prior studies into skills required for STEM graduates (Hernandez-March et al., 2009; Succi & Canovi,

2019). The list has been piloted among a number of STEM professionals in order to make sure that the list of skills is relevant. This step was important due to the fact that there is no list that indicates required skills for STEM university graduates in Kazakhstan and has been developed by accrediting bodies (Table _).

Table 7

List of the 18 Skills Used in the Study (Hernandez-March, Peso & Leguey, 2009; Succi & Canovi, 2019)

Type	Skill
Field-specific	Possess relevant field-specific theoretical knowledge
	Possess relevant field-specific technical skills
	Ability to apply professional knowledge and skills to job task
Generic	
	Using modern technology effectively
	Possess broad general knowledge
	Research skills
	Ability to develop innovative ideas
	Oral communication skills
	Written communication skills
	Working well in a team
	Getting on well with others in the workplace
	Ability to interact with co-workers from different or multi-cultural backgrounds
	Demonstrating leadership skills
	Demonstrating ethical standards
	Management skills
	Ability to work under pressure
	Capacity to work without close supervision

In the second section employers are asked to identify how satisfied they are with the skills of university graduates of the chosen university, whereas graduates are asked to assess their own skills acquired at the university using a 5-point Likert scale where 1=very dissatisfied/very poor, 2= dissatisfied /poor, 3=neutral/average, 4=satisfied/good, 5=very satisfied/excellent.

The third section is devoted to the question of responsibility of different stakeholders, such as university, student and employer, in developing students' skills. Employers and graduates are asked to rate the importance of the role of university, student and employer in students' skills development on a five-point Likert Scale where 1= not important, 2= of little importance, 3= neutral, 4= important, 5= very important.

The fourth section of the questionnaire deals with demographic data of graduates and employers. Employers are asked about the area of business, size of the company and ownership type. Graduates are asked about their gender, education background and current employment status.

Reliability of the scale has been checked using Cronbach's alpha (Cronbach & Meehl, 1955). Both reliability in importance (0.868) and reliability in satisfaction (0.878) were found to be greater than 0.7 which indicates that the instrument is reliable and can be used to collect data (Mujis, 2004). Construct validity was shown via principal component analysis (Emmons, 1984). Due to the fact that not all employers might speak English, the questionnaire was available in both English and Russian languages.

In order to collect qualitative data, twelve semi-structured in-depth interviews, nine with graduates and three with employers, were conducted for this study. Semi-structured interviews were chosen purposefully as they provide a researcher with flexibility and opportunity to engage into discussion, ask additional questions and find out more details (Creswell, 2012). The interview protocol included questions about the most important skills for STEM graduates to get employed, graduates' skill sets and work readiness, and the role of university, student and employer in the development of students' skills. In order to ensure that all questions are easily understandable, two pilot interviews were conducted before data collection: one with a university graduate and one with a human resources manager.

Data Collection Procedures

Once the author of the study received approval from the Ethics Committee, the process of data collected began. Quantitative and qualitative data was collected separately from each other between December and March, 2020.

Due to the restricted access to email addresses of university graduates and employers, a recruitment letter with the link to the online questionnaire was sent by the Career and Advising Center of the chosen university. The recruitment letter provided information about the author and the purpose of the study. The consent form was incorporated into the questionnaire and presented on its first page. It informs participants about the objectives of the study, data collection procedures, and participants' rights. It takes approximately seven minutes to complete the survey. Two reminders have been sent in order to obtain the desired response rate. However, after several attempts have been made to recruit participants via emails, the response rate remained low. The assumption of why such results appeared is that graduates might rarely check their university emails after finishing education, whereas employers might be limited by organizational policies with regards to protecting employees' information. In order to increase the number of responses, snowball sampling has been employed by the researcher (Creswell, 2012), meaning that those graduates and employers who took part in the online survey and participated in in-depth interviews, were asked to share the link to the questionnaire with their former university group mates or colleagues. Additionally, some graduates were contacted through a professional networking website. Participants' rights and privacy were taken into account, so the message sent through the website contained the same information as the recruitment letter, such as information about the author, purpose and benefits of the study. Also, in case there was no reply, it was taken as a rejection to participate and no follow-up messages were sent.

The collection of qualitative data started slightly later due to the fact that an invitation to take part in an interview was included into the online questionnaire. The time of an interview was always chosen for participants' convenience. All interviews were conducted online, via video call on Skype and lasted for approximately 30 minutes. Before starting the interview, participants were one more time informed about the purpose of the study, data collection procedures and participants' rights. Eleven interviews were recorded when given participants' permission; one employer participant refused to being recorded, so in this case the researcher took detailed notes during the interview.

Data Analysis

Parallel mixed methods analysis has been used in this study, meaning that two data sets were analyzed separately and merged only in the writing phase (Teddlie & Tashakkori, 2009).

Firstly, quantitative data was analyzed using IBM SPSS Statistics 23, software which is widely employed in social science research. With regard to the first and the second research questions, descriptive statistical analysis was employed to calculate means for importance and satisfaction with graduates' skills separately for graduates and employers. In order to check if there were significant difference between graduates and employers' perceptions, inferential statistical analysis was employed. As for the third research question, descriptive statistical analysis was used to measure the importance of the role of university, student and employer in developing students' skills separately for graduates and employers.

Secondly, qualitative data was analyzed using thematic approach. Throughout the data collection process, all interviews were manually transcribed into text files by the author of the study in accordance with the idea that "transcription is not a passive act, but instead provides the researcher with a valuable opportunity to actively engage with his or her research material right from the beginning of data collection" (Hesse-Biber & Leavy, 2006, p.347). As

interviews in this study were conducted in Russian language, they were transcribed verbatim and only specific quotations were translated into English to be later included into findings chapter. Once all interviews were transcribed, each transcript was read several times and coded to find "excerpts of data that conceptually 'hang together" (Mertens, 2009). Furthermore, codes which emerged from the data were grouped into larger categories and themes and then analyzed how they are interconnected.

Thirdly, the results obtained from two data sets were brought together when discussing findings of the study, where "two types of data actually meet and are intended to have an interactive relationship with the intention of seeing how they might inform each other" (Mertens, 2009, p. 431).Thus, in this study quantitative results are followed by qualitative findings, with special attention paid to the convergence or divergence of the results of two datasets. Finally, conclusions were generated based on the results from quantitative and qualitative datasets, which were analyzed independently yet allowed 'talk to each other' (Teddlie & Tashakkori, 2009, p.231).

Ethical Issues

Before starting the data collection process, the approval from the ethics committee of Graduates School of Education was obtained. The risks related to this research are minimal. One of the possible risks is a feeling of discomfort which might occur when university graduates start assessing how well their skills were developed after graduation and employers when they are asked about their employees' skills. In order to minimize this risk, prior to collecting data, both quantitative and qualitative, participants of the study were introduced to the consent form which includes information about participants' rights, the purpose of the research, and potential risks. In case of the online survey, the consent form was incorporated into the questionnaire and presented on the first page. The written consent form indicates

participants' right to skip any question they are reluctant to provide an answer for and stop participating in this study without any penalty. Participants of the study were asked to read it and agree or disagree to participate. Participation in this study is voluntary and does not provide any financial incentives for participants. Participants of the study are guaranteed confidentiality and anonymity of their survey and interview responses.

Participants' names were not asked during the survey. Moreover, the researcher used Qualtrics software which encrypts the data, so no one, including the researcher, is able to identify the participants. However, at the end of the survey, participants were invited to take part in follow-up interviews. If they decided to agree, they had to provide contact information such as an email address. Nevertheless their responses to this survey will remain confidential and no names or identifying information will appear in any publications.

Before starting an individual interview, a participant was asked to sign a consent form and to give permission to record the conversation. If a participant disagreed to record the conversation, the researcher took notes. Data collected during individual interviews were de-identified to provide participants' anonymity and confidentiality. Moreover, participants' names and any other subject data were removed from interview notes. Participants were offered to meet at any time and place convenient for them as they might be busy at work.

The data were used only by the author of the study and stored privately. After the research finishes, the original data will be destroyed. The results are presented in a generalized way without indicating the participants.

Chapter 4. Findings

This chapter presents the findings of the convergent mixed methods study which aimed at identifying the most important skills for STEM graduates, to reveal how satisfied employers are with graduates' performance and how graduates themselves assess their skills attained at the university, and to bring more understanding of what role universities, employers and students play in developing students' skills. Quantitative results are presented first and followed by qualitative findings. The survey and interviews' results are compared and final conclusions are based on the results of two datasets.

Principal Component Analysis

In order to group the 18 skills into broader categories, principal component analysis (PCA) with a Varimax rotation was employed for this study. PCA allows researchers to reduce the number of variables and organize them in accordance with the underlying factors (Hotelling, 1993). First, Kaiser-Meyer-Olkin (KMO) measure and Bartlett's test of sphericity were employed in order to check if factor analysis can be applied to the list of skills in this study. If KMO measure is greater than 0.7, and Bartlett's test of sphericity is significant, the data can be used in PCA (Kaiser, 1970; Kaiser & Rice, 1974). Table 8 shows the results of Kaiser-Meyer-Olkin (KMO) and Bartlett's test.

Table 8

The Results of KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.858
Bartlett's Test of Sphericity	Approx. Chi-Square	1232.488
	df	153
	Sig.	.000

As the KMO measure is 0.858 and Bartlett's test of sphericity resulted in approximate Chi-Square of 1232.488 and spherisity of 153 with significant level of 0.000, factor analysis

can be applied to the data in this study and construct validity is demonstrated (Emmons, 1984). In order to extract the factors, principal component analysis (PCA) based on assumption of eigenvalues equal to or greater than one and Varimax rotation was employed. The PCA yielded four factors with eigenvalue greater than one (Table 9).

Table 9

Rotated Component Matrix. Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization

Skill	Component			
	1	2	3	4
Getting on well with others in the workplace	.778			
Ability to interact with co-workers from different or multi-cultural backgrounds	.761			
Working well in a team	.759			
Demonstrating leadership skills	.697			
Demonstrating ethical standards	.633			
Oral communication skills	.597			
Management skills	.513			
Written communication skills	.484			
Possess relevant field-specific technical skills		.839		
Possess relevant field-specific theoretical knowledge		.783		
Ability to apply professional knowledge and skills to job tasks		.703		
Ability to solve problems			.744	
Ability to work under pressure			.734	
Capacity to work without close supervision			.480	
Research skills				.781
Ability to develop innovative ideas				.719
Possess broad general knowledge				.535
Using modern technology effectively				.359

These four factors are responsible for 57.231% of the overall variance (22.110%, 12.029%, 11.703%, 11.389%). Four categories of skills were labeled by the researcher as follows:

F1: *Communication and Cooperation* (e.g. getting on well with others in the workplace, ability to interact with co-workers from different or multi-cultural backgrounds,

working well in a team, demonstrating leadership skills, demonstrating ethical standards, oral communication skills, management skills, written communication skills);

F2: *Field-Specific Knowledge and Skills* (e.g. possess relevant field-specific technical skills, possess relevant field-specific theoretical knowledge, ability to apply professional knowledge and skills to job tasks);

F3: *Methodological Skills*: (e.g. ability to work under pressure, ability to solve problems, capacity to work without close supervision);

F4: *Knowledge-Related Skills* (e.g. research skills, ability to develop innovative ideas, possess broad general knowledge, using modern technology effectively).

Overall, in this study 18 skills are grouped into *Field-Specific Knowledge and Skills* and generic skills (*Communication and Cooperation, Methodological Skills, Knowledge-Related Skills*) based on the results of principal component analysis. It should be noted that while the categories were formed using statistical analysis and labeled by the researcher, they are also in line with the existing literature (Bunk, 1994; Hernandez-March et al., 2009; Kohler, 2004). Thus, *Field-Specific Knowledge and Skills* include in-depth theoretical knowledge and technical skills related to a particular academic discipline or professional field. On the other hand, generic skills, e.g. *Communication and Cooperation, Methodological Skills,* and *Knowledge-Related Skills,* are easily transferable and can be applied in diverse professional areas. In particular, *Communication and Cooperation* category includes skills which help individuals to articulate ideas and interact with each other in an effective way, *Methodological Skills* are concerned with abilities to manage tasks or projects, and *Knowledge-Related Skills* are linked to cognitive abilities, such as learn and use new information, develop concepts, etc. (Hernandez-March et al., 2009; Kohler, 2004).

Perceived Importance of Skills in STEM Disciplines

In order to address the first research question, the respondents of the study were asked to evaluate the importance of the 18 skills (Hernandez-March et al., 2009; Succi & Canovi, 2019) using a 5-point Likert Scale where 1= not important, 2= of little importance, 3= neutral, 4= important, 5= very important.

To calculate the perceived importance of categories such as *Field-Specific Knowledge and Skills, Methodological Skills, Communication and Cooperation* and *Knowledge-Related Skills*, factor scores were calculated using the means of original variables (Thompson, 1993). Table 10 highlights the results.

Table 10

Importance of Skill Categories Perceived by Graduates and Employers

		Methodological Skills	Communication and Interaction	Field-Specific Knowledge and Skills	Knowledge-Related Skills
Graduates	Mean	4.32	4.11	3.98	3.78
Employers	Mean	4.23	3.97	4.02	3.95

The results show that all four categories are perceived to be important by both graduates and employers, with importance mean greater than 3.0. It can be observed that *Methodological Skills* are regarded as the most important category by both groups of respondents. Employers and graduates are also in agreement with regard to *Knowledge-Related Skills* - the category was ranked as the least important by both groups, however still substantially important. On the other hand, graduates and employers' perceptions with regard to *Communication and Cooperation* and *Field-Specific Knowledge and Skills* differ. Thus, graduates seem to place greater importance on *Communication and Cooperation* than *Field-*

Specific Knowledge and Skills, whereas employers ranked the former category lower than the latter.

In order to get more in-depth understanding, means for importance of individual skills were calculated using descriptive statistical analysis separately for graduates and employers (table 11).

Table 11

Importance of Individual Skills Perceived by Graduates and Employers

Category	Variable	Graduates		Employers	
		Mean	SD	Mean	SD
Methodological Skills	Ability to solve problems.	4.48	.659	4.37	.761
	Ability to work under pressure	4.43	.698	4.21	.787
	Capacity to work without close supervision	4.06	.826	4.11	.809
Communication and Cooperation	Oral communication skills	4.41	.750	4.16	.688
	Written communication skills	4.02	.974	4.05	.911
	Working well in a team	4.43	.775	4.26	.653
	Getting on well with others in the workplace	4.27	.824	4.26	.733
	Ability to interact with co-workers from different or multi-cultural backgrounds	4.09	.921	4.21	.787
	Demonstrating leadership skills	3.73	.889	3.58	1.071
	Demonstrating ethical standards	4.01	1.028	4.00	1.000
	Management skills	3.91	.919	3.26	1.147
Field-Specific Knowledge and Skills	Possess relevant field-specific theoretical knowledge	3.73	.927	3.89	1.049
	Possess relevant field-specific technical skills	4.06	.942	4.00	1.054
	Ability to apply professional knowledge and skills to job tasks	4.14	.909	4.16	.688
Knowledge-Related Skills	Using modern technology effectively	4.16	.836	4.32	.582
	Possess broad general knowledge	3.62	.924	3.84	.898
	Research skills	3.69	1.014	3.84	.688
	Ability to develop innovative ideas	3.65	.876	3.79	.787

As importance means of all skills were found to be greater than 3.0 (midpoint of the scales), all 18 skills are perceived to be important by both groups of respondents, namely graduates and employers. Furthermore, it can be observed that graduates and employers' perceptions are quite similar. Thus, both groups of respondents highly value *ability to solve problems, working well in a team, ability to work under pressure,* and *getting on well with others in the workplace.* Graduates also ranked *oral communication skills* as one of the most important skills, whereas employers stressed the importance of *using modern technology* and *ability to interact with co-workers from different or multi-cultural backgrounds* for STEM graduates to get employed. Although considerably important (with mean greater than average 3.0 but less than 4.0), *possess broad knowledge, research skills, ability to develop innovative ideas, management skills, demonstrating leadership skills,* and *possess relevant field-specific theoretical knowledge* appeared to be the least important skills perceived by graduates and employers participating in the study. Figure 2 shows the importance of individual skills perceived by graduates and employers in a graphic way.

In order to check if there were significant differences between employers and graduates' perceptions, Mann-Whitney U test was employed. The analysis did not reveal any significant differences, except for *management skills* that were ranked higher by graduates than employers in terms of importance for STEM graduates ($U = 1.120$, $p = .012$). This might be explained by the fact that *management skills* are typically essential for those who apply for managerial positions, whereas university graduates traditionally start from entry-level positions. Thus, employers are probably not very interested in such skills when hiring recent graduates. At the same time, graduates themselves usually seem to be quite ambitious for climbing career ladder and pursuing managerial career, thus they perceive such skills to be important for them. So, the difference in graduates and employers' perceptions with regard to

the importance of *management skills* might be explained by varied requirements for entry-level and managerial positions.

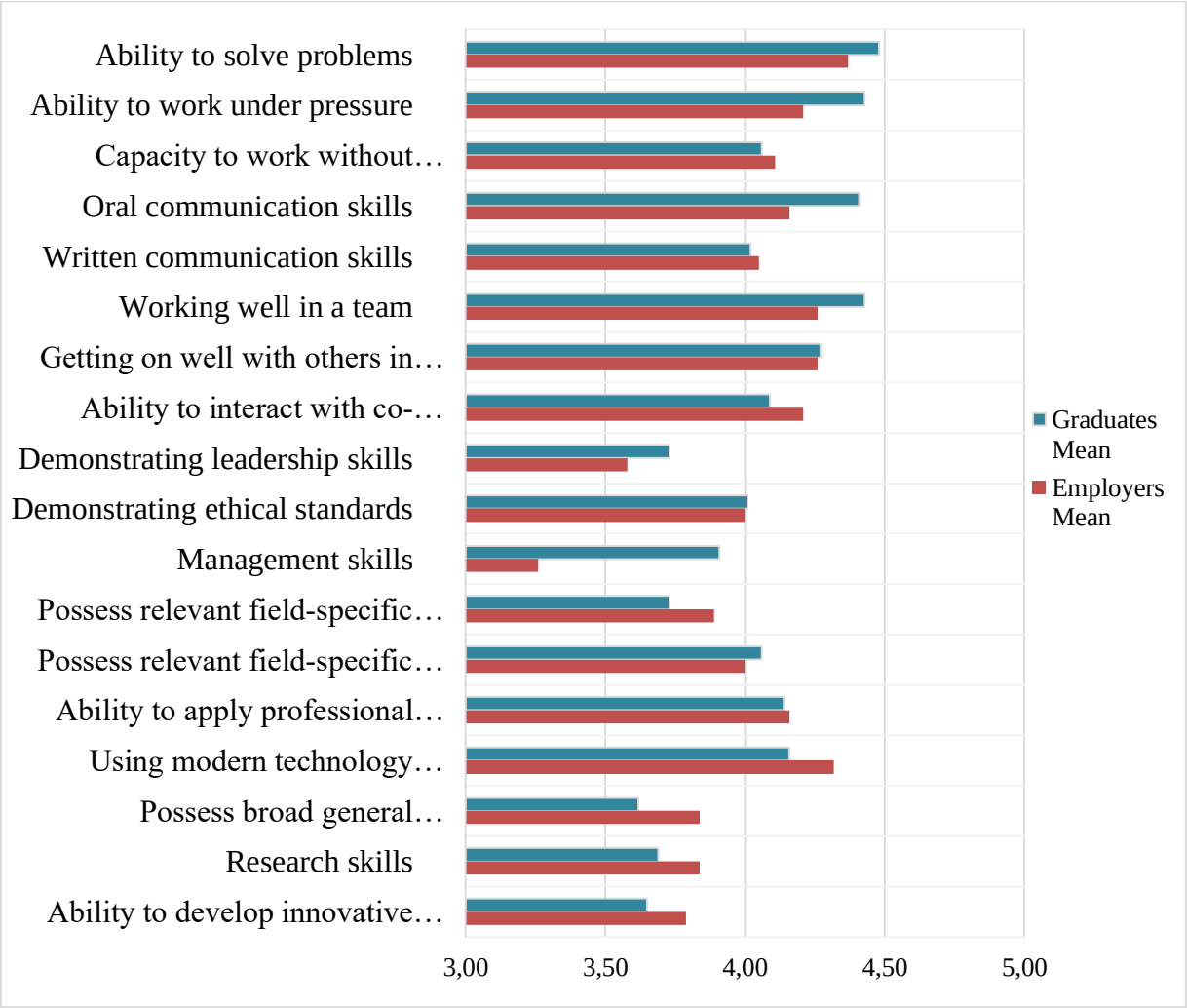

Figure 2. Importance of Individual Skills Perceived by Graduates and Employers

Analysis of graduates' perceptions by major, employment status, and gender.

In order to check if there are significant differences in graduates' perceptions, the data was also analyzed based on graduates' major and employment status. One-Way ANOVA is applied to test if there is significant difference in perceptions of more than two groups. However, Shapiro-Wilk and Kolmogorov-Smirnov tests showed that the distribution of importance and satisfaction was not normal and ANOVA test cannot be used. Thus, a non-

parametric Kruscal-Wallis test was employed to test if there were significant differences among graduates' perceptions. The data was analyzed by grouped majors, such as engineering (chemical Engineering, civil Engineering, electrical and electronic Engineering, and mechanical engineering), digital sciences (computer science, robotics and mechatronics), and natural sciences and mathematics (biology, chemistry and mathematics). Majors were grouped in order to increase the reliability of the test's results. Significant differences were found between graduates of different majors regarding the importance of the following skills: *written communication skills, research skills, working well in a team, management skills, using modern technology effectively, ability to interact with co-workers from different or multi-cultural backgrounds,* and *ability to develop innovative ideas.*

Thus, graduates who studied digital sciences ranked *written communication skills* (H= 13.895, *p= .001*), *working well in a team* (H= 11.819, *p*= .003), *and management skills* (H= 12.629, *p*= .002) significantly lower than graduates of other majors. Such findings might be explained by the nature of IT industry where professionals use specific programming languages and typically present their results in a form of programs, applications, etc., but not in a form of written reports or papers. Also, IT professionals might spend substantial amount of time working individually, and not often communicating with colleagues or managing other professionals. At the same time, those who studied natural sciences and mathematics ranked *research skills* higher than other groups (H= 10.544, *p*= .005). These findings might be explained by their employment status and industries they represent: many of those who studied natural sciences and mathematics are working in the area of science and education or pursuing further education where *research skills* are traditionally of high importance. Peculiarly, those who studied natural sciences and mathematics ranked *using modern technology effectively (*H=8.336, *p*= .015*)* and *ability to develop innovative ideas* (H= 7.732,

p= .021) significantly higher than those who studied digital sciences (no other differences between these groups and engineering were found). Finally, *ability to interact with co-workers from different or multi-cultural backgrounds* was ranked significantly higher by engineering graduates than those who studied digital sciences (H= 6.858, *p*= .032); none of other pairwise comparisons were significant. These findings suggest that skill sets required for STEM graduates differ based on a major, thus it is important to take it into consideration when designing and implementing curricula.

Furthermore, the data was analyzed by employment status. Kruscal-Wallis test was used to see if there are differences between three groups: full-time employed, part-time or self-employed, and unemployed. The analysis showed that the perceived importance of *research skills, demonstrating leadership skills* and *demonstrating ethical standards* was significantly affected by the employment status. Step-down follow-up analysis showed that graduates who are full-time employed ranked *research skill* significantly lower than other groups (H= 16.337, *p*= .001). Possibly, job duties of STEM graduates do not always include research-related tasks or projects, so *research skills* are not perceived as profound, unless it is a research position in academia, scientific center, laboratory, etc. Part-time or self-employed graduates ranked *demonstrating leadership skills* higher than other groups, whereas those who are not employed ranked them significantly lower (H= 15.351, *p*= .002); no significant difference between full-time employed and those who are pursuing further education was found. Probably, those who are part-time or self-employed need to take on leaderships role quite often, for instance, find projects or clients, make decisions, show initiative, etc., thus *leaderships skill* are of high importance for them. Interestingly, those who are not employed ranked *demonstrating ethical standards* significantly lower than other groups (H= 4.188, *p*= .003). These findings show that graduates' career destinations influence their perceptions of important skill sets. Therefore

understanding of the career paths students plan to pursue after graduation, e.g. academic, corporate or self-employed, might inform universities about the skills which have to be taught so as to ensure students' professional success in the future.

Mann–Whitney U test was applied to analyze the data by gender. Significant differences were found between female and male graduates with regards to the following skills: *possess broad general knowledge* ($U = 3.616$, $p = .038$), *research skills* ($U = 3.744$, $p = .012$), *working well in a team* ($U = 3.635$, $p = .023$), and *demonstrating ethical standards* ($U = 3.745$, $p = .012$). Female graduates ranked the above mentioned skills significantly higher than their male counterparts, indicating that gender differences might exist on labor market with regard to job requirements.

Analysis of employers' perceptions by industry, company size, and ownership type. Kruscal-Wallis test was employed to check if there were significant differences in employers' perceptions when data analyzed by company size, ownership type and industry. With regards to the ownership type and industry, no significant differences were found. However, when data was analyzed by company size, it appeared that companies with 100-499 employees ranked research skills higher than larger ones with 1000 and more employees ($H= 6.003$, $p= .05$). Possibly, employees of smaller companies have diverse job duties, get engaged into several projects and generally cover more responsibilities than their peers in larger companies.

Field-specific knowledge and skills. With regard to the importance of *Field-Specific Knowledge and Skills*, qualitative findings support the survey's results. Although graduates believe that field-specific theoretical knowledge and related technical skills are important for their career, it was mentioned by several participants of different majors, both females and

males, that such skills can be acquired at the workplace using learning-by-doing approach. As graduate participant 1 explained:

> Nowadays communication skills, critical thinking, being fast, being able to solve problems are in demand. Technical skills will be acquired with time. They are not so important. Hard skills are like a 'minimum viable product': you have them, but [you] do not expect magic. (Chemical engineering graduate)

Furthermore, several participants of different majors, both male and female, mentioned that *ability to learn quickly* (the skill which was not included into the online survey) is one of the most important skills they have acquired at the university. Graduate participant 7 stressed:

> I can name a lot of technical skills which were important but again they were compensated by learning skills. Because even if I did not have some technical skills, it was not important as they [skills] could be learnt quickly [in the workplace]. (Computer science graduate)

Graduate participant 5 noted, "When we [graduates] come to a workplace, we face mistrust because of the absence of practical skills, but after a short period of time, all questions disappear. Because we know how to learn and understand how things work" (electric and electrical engineering graduate).

Employers participating in the interviews perceive field-specific knowledge and skills to be quite important for graduates, though lack of such skills does not seem to be a deal-breaker for them. Employer participant 2 stressed that it is critical for their company to find employees who share core values of the company:

> First of all we pay attention not to technical skills because we understand that graduates are very fresh and mainly possess theoretical knowledge. First of all we pay attention to their personal competencies, if they coincide with our company's values. (Human resources manager, construction company)

Similarly to graduates' views, all employers noted that their companies are ready to support fresh graduates in acquiring practical skills. They generally believe that universities are limited in terms of equipping students with practical skills, so they do not expect fresh

graduates to demonstrate excellence in this area. However, employer participant 1 stressed that their company does require students to demonstrate good knowledge of physics and mathematics:

> The company can provide training and teach all other aspects. But in order to make sure that the person who we have hired will understand all the information we will provide him or her with, they should have basic skills. (Human resources manager, construction and engineering company).

Thus, all employers expect fresh graduates to demonstrate broad understanding of the subject and motivation to learn, and are ready to support them in acquiring practical skills.

Methodological skills. The importance of *Methodological Skills*, which appeared to be the most valued category of skills for both graduates and employers according to survey's results, was confirmed by qualitative findings. During the in-depth interviews with graduates, ability to solve problems was mentioned by three participants, all graduates of engineering majors, as one of their main job duties. Graduate participants of other majors, such as computer science and biology, also discussed it throughout interviews with regards to performing job tasks and implementing projects. Thus *ability to solve problems* seems to be perceived by graduates as integral part of their professional skillsets. As graduate participant 1 explained, "It [ability to solve problems] is a complex skill and it is important for all industries". The same seems to be true for employer participants. Employer participants 1 and 3 noted that while hiring new employees, their companies pay close attention to candidates' analytical and problem solving abilities. Therefore, they offer candidates to solve different tasks and cases as a part of their hiring process.

Along with the perceived importance of problem-solving skills, *ability to work under pressure* was mentioned by graduate participants of different majors, specifically with regards to developing new skills in a short period of time and meeting deadlines. Graduate participant

4, a civil engineer, noted that ability to work under stress is crucial for his job as sometimes projects have very tight deadlines and nevertheless have to be finished on time.

Communication and cooperation. Graduates actively discussed *Communication and Cooperation Skills* during in-depth interviews. The majority of graduates participating in the interviews mentioned *oral communication skills* as one the most important skills for their career. However, during the conversations it became clear that the term '*oral communication skills*' is quite broad and participants tend to discuss different aspects. Thus, graduate participant 3 who currently works at a laboratory pointed out the importance of oral and written communication skills for scientists, "It is important to be able to explain biology using accessible language. [Good communication skills] help to convey the results to ordinary people, to persuade a person in written or oral form to prolong a grant, for example". Graduate participant 4, currently a civil structure engineer, emphasized the overall importance of generic skills and mentioned that communication skills are important when it comes to getting promoted, "Generic skills are important when communicating in meetings, giving presentations, working well in a team, communication skills [are important] to get promoted and grow professionally – establish a dialog with management". Similarly, graduate participant 9, also a civil engineer, mentioned the importance of negotiating skills for career development, specifically when it comes to contract or salary negotiation. Graduate participant 6, who works as a process engineer, pointed out that communication with people is an integral part of any engineer's career, "Construction site is closely connected with communicating with people. That is why soft skills are so important, so called human skills, communication with people, defending your point of view, ability to get on well with different people".

With regard to *working well in a team*, graduate participant 2 stressed that his current job involves a lot of team work, more than he expected as a student: "Real life is different.

There are a lot of interactions [within a tem], responsibility for your own actions, your team's actions. When I was a student I did not realize how difficult it can be to work in a team". Similarly, graduate participant 7, computer science graduate, noticed that as she works in a small company, and her job requires well-developed teamwork and communication skills.

The increasing importance of generic skills, specifically *Communication and Cooperation*, has been mentioned by employer participants as well. Employer participant 1 noted that while their company used to asses generic skills only during the final interviews with candidates (once it is clear they are satisfied with technical skills of a candidate), they have changed their approach and now evaluate *oral communication skills* starting from the first interview. All employers stressed that possessing well-developed *oral communication skills* is of high importance for them when hiring fresh university graduates. As employer participant 1 explained:

> We work not only in the office. We send them [engineers] on business trips. And during such trips they closely interact with workers of different level. It can be builders, other workers. So they have to be able to establish contact, communicate, and understand them. (Human resources manager, construction and engineering company).

Employer participant 3 stressed that ability to present ideas and interact effectively with colleagues is essential, "We need people who can articulate their ideas clearly. It is a must. Also we seek those who are ready to work as a part of a team, friendly and not arrogant" (human resources manager, oil and gas).

Knowledge-related skills. *Knowledge-Related Skills* were found to be of the least perceived importance for both graduates and employers according to the survey's results. During the interviews, graduate and employer participants did not mention *ability to develop innovative ideas* or *possess broad general knowledge* among the most important skills for STEM graduates. However, with regard to the importance of *research skills,* in-depth

interviews produced mixed findings. In line with the survey's results, several graduate participants, 2 and 6, mentioned that they rarely or never use *research skills* at their current jobs. For example, graduate participant 2, a mechanical engineer, noted, "I participated in research activities [while being a student]. But I cannot say that it helps me now at work. I believe that research skills are useful for those who decide to stay in an academia". On the other hand, graduate participant 1, a chemical engineer, noted:

> [The fact that] we analyzed a large amount of data [at university] helps. It is needed nowadays, in the information age. Information comes from everywhere, [you need] to sort, analyze, find trends, understand. Practical skills, such as information analysis, experiments, help a lot. (Chemical engineering graduate)

Not surprisingly, those interview participants who work in scientific laboratories, graduate participants 2 and 5, believe that research skills are highly important for their career. Also, graduate participant 7, a computer science graduate, stressed that *research skills* are useful in her current position which involves research.

Interviews with employers participants also produced mixed results. Generally, employers did not mention research skills as something crucial for university graduates, but at the same time employer participant 2 mentioned that research skills are quite important for university graduates, pointing out that well-developed skills of "analyzing large amount of data, comparing, doing SWOT and other types of analysis" are helpful for performing job tasks.

The online survey showed that employers believe that *using modern technology effectively* is one the most important skills for graduates to possess. Employer participant 1 mentioned that their company would be happy if fresh graduates possessed some knowledge about software used by professionals in the industry, "It would be good if university graduates knew how to use professional software. Usually universities neglect this aspect and students

have to learn it themselves". However, employer participant 2 noticed that their company has unique software, created specifically for the needs of their company, so all new employees despite their work experience have to learn how to use it. Thus, it seems that in terms of the software and possibly other equipment companies' requirements vary.

Overall, in relation to the first research question, it can be observed that quantitative and qualitative findings mainly support each other. Thus, the importance of *Methodological Skills* and *Communication and Cooperation* was highlighted in both sets of data. With regard to *Knowledge-Related Skills*, the survey suggests that this category is of least importance for both graduates and employers. During in-depth interviews several graduate participants, all engineers, confirmed that they rarely apply *research skills* to job tasks, except doing rigorous information search and analysis. However, three interview participants, graduates of biological sciences, computer science, and electrical and electronic engineering, stressed the importance of *research skills* for their career. This suggests that the perception of the importance of *research skills* for graduates vary across majors and industries and mainly depend on specific if job duties. Additionally, *research skills* seem to be a complex area and include many aspects, for example analytical abilities, academic writing, etc. As for *Field-Specific Knowledge and Skills*, similarly to the survey's results, graduates participated in interviews seemed to prioritize generic skills, specifically with regard to communication and problem-solving abilities. With regard to employers, although they do not have high expectations of students' s field-specific skills, they expect to see good knowledge of basic disciplines, such as mathematics or physics, so in the future graduates will be able to acquire practical skills. It is worth noting that qualitative findings did not reveal differences in graduates' perceptions with regard to gender.

Satisfaction with Graduates' Skills Perceived by Graduates and Employers

With regards to the second research question, graduates were asked to assess how well their skills were developed after graduation, whereas employers were asked to indicate how satisfied they are with graduates' skills using a 5-point Likert Scale where 1=very dissatisfied/very poor, 2= dissatisfied /poor, 3=neutral/average, 4=satisfied/good, 5=very satisfied/excellent.

Table 12 presents perceived satisfaction with skills categories such *Methodological Skills, Communication and Cooperation, Field-Specific Knowledge and Skills,* and *Knowledge-Related Skills*.

Table 12

Satisfaction with Skill Categories Perceived by Graduates and Employers

		Methodological Skills	Communication and Interaction	Field-Specific Knowledge and Skills	Knowledge-Related Skills
Graduates	Mean	3.99	3.96	3.44	3.84
Employers	Mean	3.67	4.01	3.86	3.79

Generally, both groups of respondents are quite satisfied with graduates' skills as all satisfaction means were found to be greater than 3.0. Graduates are mainly satisfied with how well their *Methodological Skills, Communication and Cooperation,* and *Knowledge-Related Skills* were developed after graduation. However, they were found to be the least satisfied with *Field-Specific Knowledge and Skills*. On the other hand, employers are mainly satisfied with graduates' *Communication and Cooperation, Field-Specific Knowledge and Skills,* and *Knowledge-Related Skills.* With regard to graduates' *Methodological Skills*, employers appeared to be the least satisfied with this category.

In order to get a more complete picture, means for satisfaction of individual skills were calculated using descriptive statistical analysis separately for graduates and employers (table 13).

Table 13

Satisfaction with Individual Skills Perceived by Graduates and Employers

Category	Variable	Graduates		Employers	
		Mean	SD	Mean	SD
Methodological Skills	Ability to solve problems.	4.02	.800	3.63	.761
	Ability to work under pressure	4.13	.875	3.74	1.098
	Capacity to work without close supervision	3.83	1.017	3.63	.761
Communication and Cooperation	Oral communication skills	3.86	.864	4.00	.816
	Written communication skills	3.99	.862	4.11	.567
	Working well in a team	4.05	.773	3.95	.524
	Getting on well with others in the workplace	3.97	.799	3.89	.658
	Ability to interact with co-workers from different or multi-cultural backgrounds	3.91	1.010	4.11	.567
	Demonstrating leadership skills	3.60	.933	3.63	.496
	Demonstrating ethical standards	4.05	.830	3.89	.567
	Management skills	3.42	.977	3.53	.612
Field-Specific Knowledge and Skills	Possess relevant field-specific theoretical knowledge	3.60	.908	3.84	.501
	Possess relevant field-specific technical skills	3.24	1.008	3.74	.562
	Ability to apply professional knowledge and skills to job tasks	3.48	.919	4.00	.577
Knowledge-Related Skills	Using modern technology effectively	3.90	.882	4.16	.501
	Possess broad general knowledge	3.78	.792	4.05	.405
	Research skills	4.10	.879	3.68	.582
	Ability to develop innovative ideas	3.65	.842	3.63	.597

Graduates showed greatest satisfaction (mean higher than 4.0) with how well their skills were developed with regard to *ability to work under pressure, working well in a team, demonstrating ethical standards, ability to solve problems* and *research skills*. As for

employers, they are most satisfied with the following graduates' skills: *using modern technology effectively, written communication skills, oral communication skills, ability to interact with co-workers from different or multi-cultural backgrounds, ability to apply professional knowledge and skills to job tasks* and *possess broad general knowledge.*

On the other hand, graduates ranked *ability to apply professional knowledge and skills to job tasks, possess relevant field-specific technical skills,* and *possess relevant field-specific theoretical knowledge* as ones of least developed skills. Employers are the least satisfied with graduates' *ability to solve problems, capacity to work without close supervision*, and *research skills.* Both groups expressed least satisfaction with regard to *management skills, demonstrating leadership skills,* and *ability to develop innovative ideas.* Figure 3 demonstrates satisfaction with individual skills perceived by graduates and employers in a graphic way.

In order to check if there were significant differences between employers' and graduates' perceptions Mann-Whitney U test was employed. The results show that employers ranked significantly higher the following skills: *possess relevant field-specific technical skills* ($U = 2.135$, $p = .036$) and *ability to apply professional knowledge and skills to job tasks* ($U = 2.205$, $p = .015$). Interestingly, employers ranked *research skills* ($U = 1.115$, $p = .011$) lower than graduates. These findings show that graduates in this study are more critical toward their filed-specific knowledge and skills than employers. On the other hand, graduates are more confident about their *research skills* than employers.

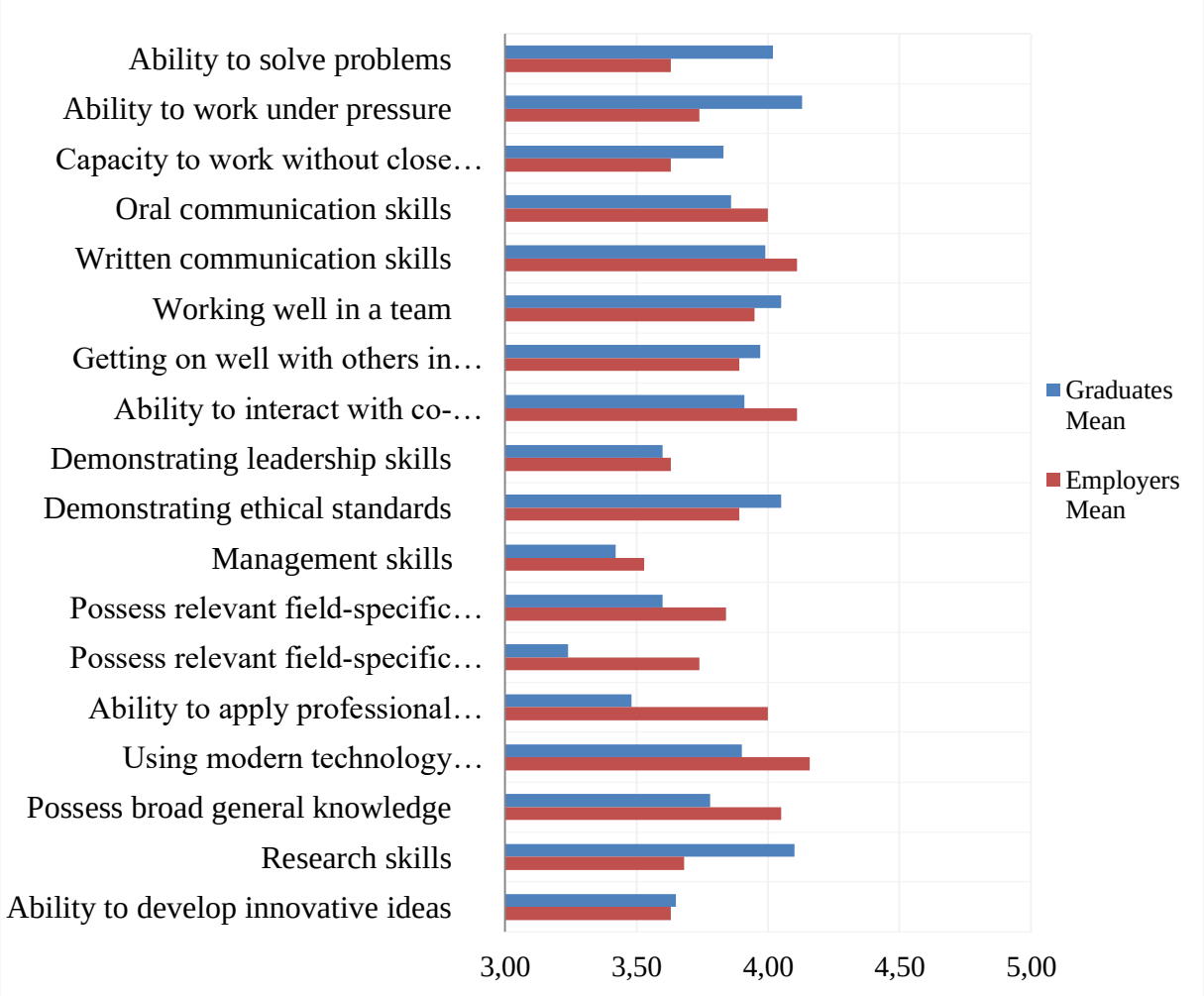

Figure 3. Satisfaction with Individual Skills Perceived by Graduates and Employers

Kruskal-Wallis test was run to identify differences in graduates' perceptions by majors. Interestingly, the results show that those who studied Digital Sciences ranked *management skills* (H= 11.231, *p*= .004), *working well in a team* (H= 7.289, *p*= .026), and *leadership skills* (H=11.719 , *p*= .003) as less developed in comparison with graduates of other majors. When data was analyzed by employment status, the results show that those graduates who are currently pursuing further education ranked *possess relevant field-specific theoretical knowledge* higher than those who are full-time employed (H=9.263, *p*= .026). This might be explained by the fact that graduates who are currently pursuing further education might have spent substantial amount of time acquiring theoretical knowledge while being Bachelor's

students as they planned to go back to academia for further education, so as a result they are confident about their skills now. Another possible explanation is that they have a chance to apply the theoretical knowledge acquired through Bachelor's degree to current studies and see how well they are prepared. When data was analyzed by gender no significant difference was found. With regards to employers, when data was analyzed by industry, company size, and ownership no significant difference was found.

Gaps between Required and Acquired Skills in STEM

In order to understand if there are gaps between required and acquired skills, the difference between importance mean and satisfaction mean was calculated (table 14).

Table 14

Gaps between Required and Acquired Skill Categories Perceived by Graduates and Employers

		Methodological Skills	Communication and Cooperation	Field-Specific Knowledge and Skills	Knowledge-Related Skills
Graduates	Gap	0.33	0.15	0.54	-0.06
Employers	Gap	0.56	-0.04	0.16	0.16

According to the graduates participating in this study, the biggest gap between importance and satisfaction exists in graduates' *Field-Specific Knowledge and Skills.* Furthermore, graduates believe that *Methodological Skills* and *Communication and Cooperation* also need to be improved. With regard to *Knowledge-Related Skills*, the gap appeared to be the smallest and negative, indicating that the mean of satisfaction is higher than the mean of importance for this category. As for employers, the largest gap appeared to be in graduates' *Methodological Skills.* Also, employers believe that there is a room for improvement in graduates' *Field-Specific Knowledge and Skills* and *Knowledge-Related*

Skills. With regard to *Communication and Cooperation*, employers were found to be satisfied with this category with the mean of satisfaction higher than the mean of importance.In order to dig dipper into the data, the difference between importance mean and satisfaction mean was also calculated for each skill (table 15).

Table 15

Gaps between Required and Acquired Individual Skills Perceived by Graduates and Employers

Category	Skill	Gap/Graduates	Gap/Employers
Methodological Skills	Ability to solve problems.	0.46	0.74
	Ability to work under pressure	0.30	0.47
	Capacity to work without close supervision	0.23	0.48
Communication and Cooperation	Oral communication skills	0.55	0.16
	Written communication skills	0.03	-0.06
	Working well in a team	0.38	0.31
	Getting on well with others in the workplace	0.30	0.37
	Ability to interact with co-workers from different or multi-cultural backgrounds	0.55	0.10
	Demonstrating leadership skills	0.13	-0.05
	Demonstrating ethical standards	-0.04	0.11
	Management skills	0.49	-0.27
Field-Specific Knowledge and Skills	Possess relevant field-specific theoretical knowledge	0.13	0.05
	Possess relevant field-specific technical skills	0.82	0.26
	Ability to apply professional knowledge and skills to job tasks	0.66	0.16
Knowledge-Related Skills	Using modern technology effectively	0.26	0.14
	Possess broad general knowledge	-0.16	-0.21
	Research skills	-0.41	0.16
	Ability to develop innovative ideas	0.00	0.16

The results show that graduates and employers' perceptions differ. According to the graduates, the biggest gaps can be observed with regards to the following skills: *possess relevant field-specific technical skills, ability to apply professional knowledge and skills to job tasks, oral communication skill, management skills, ability to solve problems* and *ability to interact with co-workers from different or multi-cultural backgrounds.* Peculiarly, *research skills* were found to have a relatively wide negative gap which indicates that satisfaction mean was higher than importance one. The smallest gaps were found in *written communication skills*, and *demonstrating leadership skills*, where importance mean was found to be slightly higher than satisfaction mean; with regards to *demonstrating ethical standards* and *possess broad general knowledge*, the identified gaps were also quite small but with satisfaction mean higher than importance mean. Interestingly, importance and satisfaction means *of ability to develop innovative ideas* perfectly coincided.

As for employers, the biggest gaps were found in the following skills: *ability to solve problems, capacity to work without close supervision, ability to work under pressure* and *getting on well with others in the workplace.* With regards to *possess broad general knowledge* and *management skills*, the gaps appeared to be quite large and negative indicating that satisfaction mean is greater than importance mean. The smallest gaps appeared in *possess field specific theoretical knowledge* (importance mean higher than satisfaction); regarding *written communication skills* and *demonstrating leadership skills*, the gaps were found to be negative (satisfaction mean higher than importance). Figure 4 demonstrates gaps between required and acquired individual skills perceived by graduates and employers in a graphic way.

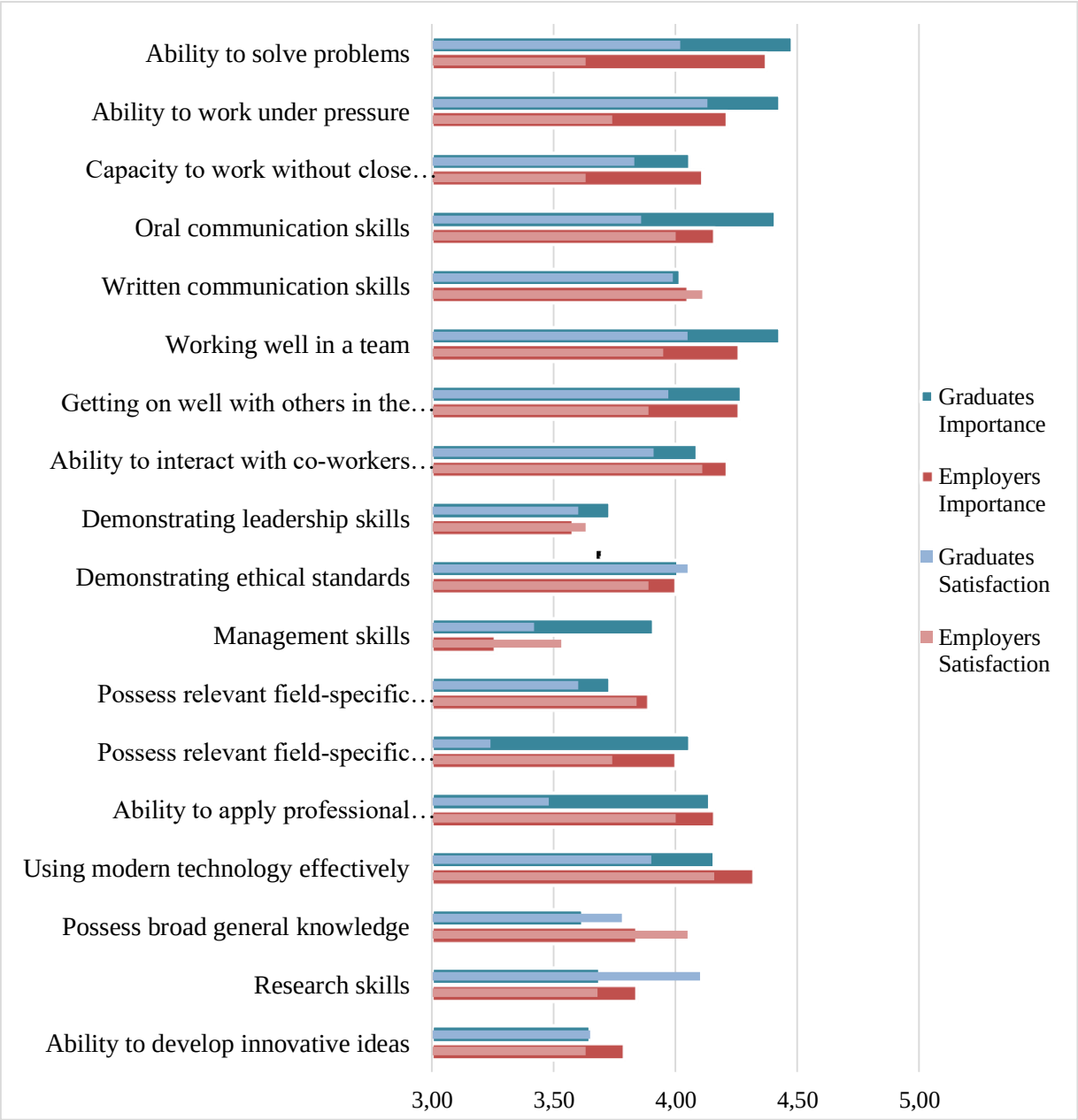

Figure 4. Gaps between Required and Acquired Individual Skills Perceived by Graduates and Employers

Field-specific knowledge and skills. In line with the survey's results, majority of university graduates interviewed for this study stressed that they are least satisfied with their *Field-Specific Knowledge and Skills*, specifically *field-specific practical skills* and *ability to apply professional knowledge to job tasks*. The causes most frequently mentioned by

participants mainly deal with inconsistency in a program's structure and content, neglect of local market realities and lack of practical activities, such as laboratory projects, case-studies, etc. Organizational matters and faculty's professionalism have also been mentioned by engineering graduates, though less frequently.

Inconsistencies in a program's structure and content. With regard to a program's organization, several engineering participants noticed that some of the courses they studied were poorly interconnected, so they had a feeling that there was no systematic approach toward teaching and learning. As graduate participant 2 explained, "We could learn something at one course and then learn the same thing at another one two years later or in parallel. There was no system, no clear plan" (mechanical engineering graduate). Similarly, graduates participant 5 stressed, "The program was unstable. Some new courses appeared, other got removed. It seemed that they [the university] still tried to understand what program was suitable" (electrical and electronic engineering graduate). Moreover, a few participants mentioned that while being students they did not always understand why some courses were included into the program and how the knowledge and skills acquired during those courses could be applied at work in the future. As a result, they did not feel motivated and tended to forget the information right after passing exams. As graduate participant 6 explained, "We took courses, we passed exams, but we did not understand why we needed them. So there were some courses which we passed we lots of struggles, but forgot everything very soon" (chemical engineering graduate).

As for a program's content, engineering graduates stressed that the program did not teach them the skill they believe is fundamental for professionals in their field. Thus, graduate participant 6, who studied chemical engineering, stated, "Creating process flow diagrams is a base, fundamentals of any technologist. We spent five years at the university and did not learn

it". Graduate participant 2, mechanical engineering graduate, highlighted, "We did schematic tasks from textbooks and lectures. Only schemes. But we were not taught how to read industrial drawings. It is the most important skill of any engineer which we have not been taught".

Neglect of local market realities. Four participants, graduates of engineering majors, stressed that the program does not take into account the realities of Kazakhstani industry. Graduate participant 8 explained:

> When we were studying, our program, in my opinion, was not made for Kazakhstani realities. It seemed like it was created for Europe or America. … But if you visit a power station [in Kazakhstan], you will see that all [equipment] is Soviet. (Electrical and electronic engineering graduate)

Graduate participant 2 pointed out that the program was 'blindly copied with all minuses" from western universities. Furthermore, two graduate participants commented on standards which are used by professionals in civil and chemical engineering: while they were taught European or American standards at the university, that knowledge turned out to be inapplicable for companies operating in Kazakhstan. As participants explained, Kazakhstani companies mainly use Soviet standards, thus graduates have to relearn and spend substantial amount of time understanding how international and Soviet standards are related. Graduate participant 6, noted, "In Kazakhstan everything is organized in accordance with ancient GOSTs [Soviet state standardization system]. We have never worked with them" (chemical engineering graduate). Graduate participant 4, talked about similar issue in civil engineering, "We studied European standards, but in Kazakhstan in 90% of cases, local GOSTs or Russian standards are used. … And we do not understand them, so we have to relearn".

Balancing theory and practice. With regards to balancing theory and practice, graduate participant 3, who studied biological sciences, stressed the importance of laboratory

projects. Although she was quite satisfied with how theoretical knowledge was combined with practical activities, she mentioned that practice in laboratories was not incorporated into some of her courses and consequently she did not learn those practical knowledge and skills which are important in her current job, “I wish we had had biochemistry or immunology with laboratory projects. I do not know the reasons why we did not have laboratory practice. Now [at work] I need laboratory skills, not theory”. Lack of laboratory projects was also mentioned by graduate participant 5.

Graduate participant 2, currently a mechanical engineer, commented on the lack of knowledge about industrial equipment. Taking into account the limitations of universities, he insisted on the importance of introducing students to the basics:

> At work I was asked about roller conveyors. I heard about that for the first time in my life, though it was not something difficult. So [universities need to] at least organize student trips to plants, show them equipment, how it is used, etc. (Mechanical engineering graduate)

Another aspect related to balancing theory and practice which was mentioned by participants is internships. While all graduates participating in the interviews believe that internships are beneficial for developing students’ skills, not all of them were satisfied with their personal experiences. Three participants mentioned that they faced difficulties with finding a company which they attributed to lack of assistance from the university’s side and generally poor connections with industry. Graduate participant 5: “At the university, taking an internship was a required component. …However, this process was not organized well, it [university] did not provide directions, there was very limited choice [of employers]” (electrical and electronic engineering graduate). Graduate participants 2 and 6 also mentioned that they experienced difficulties with finding a place for internship.

Faculty and organizational matters. Two participants, 1 and 2, mentioned that lack of consistency in schools' work, including faculty turnover and constant changes in curriculum, created difficulties for students' development. Deficiencies in subject knowledge were also attributed to lack of experience of some faculty members and their attitude toward teaching. Two participants, both engineers, stressed that the courses taught by professors who had little teaching experience and did not seem to be interested in their subject and students' progress were infective in terms of gaining knowledge and skills. Graduate participant 6 explained:

> I believe that our professors needed basic pedagogical education. The problem is that even if a professor has excellent knowledge, as a professional, he or she is simply not able to transfer it to students. … Some professors teach in such boring way, so students lose interest. (Chemical engineering graduate)

From employers' perspective, graduates of the chosen university possess good theoretical subject knowledge. However, when it comes to practical skills, they believe that graduates lack basic knowledge of equipment and software. As employer participant 1 explained:

> With regard to practical skills, I think that any graduate will never be fully ready. It comes with years [of experience]. However, as engineers, basic understanding of equipment, what a gear, beam look like is important. Due to the fact that they learn from textbooks but never see it in real life, numerous problems appear. I think that this skill can be improved through prolonging internships. (Human resources manager, construction and engineering company)

Therefore, acknowledging the limitations of the university, all employers believe that the number of internships students take throughout the Bachelor's degree should be increased. Furthermore, employer participant 2 mentioned that specifically for construction industry it is important that engineering students work at a construction site, not only in offices, during internships because "each engineer has to have a general idea of what it looks like not only on drawings but in reality".

Methodological skills. With regard to *ability to solve problems*, lack of real-life context and scenarios has been mentioned by two participants as a big disadvantage of some courses. Engineering graduates believe that using cases of real companies would be more effective than just learning a lot of theory without specific examples of how it can be implemented. Graduate participant 4 noted, "Big disadvantage is that we studied simplified, theoretical cases. … I wish the program had been created in partnership with employers, professionals in the field, so they would give real situations, real tasks, real cases" (civil engineering graduate). Similarly, graduate participant 2 stressed:

> Project management course was just lots of theory without examples how it would be implemented in practice, even though project manager is a popular profession nowadays. Real cases provided by companies would be ideal, but I did not expect that. However some examples from real business are essential. (Mechanical engineering graduate).

With regard to *ability to work under pressure*, graduates believe that they possess well-developed skills. Several participants mentioned that the fact that they experienced a lot of stress while being students, e .g. before exams, played a positive role as nowadays they are able to cope with stressful situations effectively.

However, employer participants, believe that graduates from the chosen university seem to be quite reversed and psychologically not prepared for the life outside their campus. It might explain large gaps between importance and satisfaction means with regards *to capacity to work without close supervision* and *ability to work under pressure.* As employer participant one explained:

> I am quite worried about the fact that graduates are not prepared for real life. … A person gets used that the dormitory, campus, canteen – everything is nearby. And when they have to leave their comfort zone, they do have to, it is difficult for them. (Human resources manager, construction and engineering company)

The same idea was mentioned by employer participant 2 who believes that graduates do not understand the realities of Kazakhstani job market due to the fact that they rarely leave campus and tend to forget about outside world:

> They need to understand that they stay in Kazakhstan, and realities here are different. Even if it is an international company, management style is still local, so management approaches are different. They need to be ready for this and not to create illusions. (Human resources manager, construction company)

Communication and cooperation. Graduates participating in the interviews were found to be mainly satisfied with their generic skills, in particular *Communication and Cooperation*. As they explained, the university provided them with all opportunities, in terms of both academic and extracurricular activities, for developing generic skills. Graduate participant 9 mentioned presentations frequently assigned by professors:

> Actually, almost all courses had a component which is supposed to develop soft skills. So for every course we had tasks with presentations. So because we had such component with presenting, speaking, explaining and answering questions, I think it is good and it helps me. (Civil engineering graduate)

As for extracurricular activities, graduate participants noted that participating in different social clubs help them to deal with their work duties, especially when it comes to organizing events or establishing contacts with different people. However, Participant 6 noted that the program lacks such courses as ethics or philosophy where students can discuss different topics and express their point of view. Due to his natural introversion, he was not interested in extracurricular activities, for example debate clubs, and now experiences some difficulties when communicating with managers.

It should be noted here that four participants discussed the language of instruction in relation to *communication skills*. Unsurprisingly, participants 8 and 9, who currently work abroad, believe that the fact that language of instruction at the university was English helps them a lot nowadays. Graduate participant 9:

> I have a good level of technical English, so I easily understand what I am told even if it is something technical, related to civil engineering. … The fact that our program was taught fully in English give me an opportunity to speak with any engineer, discuss technical things without misunderstandings. (Civil engineering graduate)

However, graduate participant 6, who currently works as an engineer in Kazakhstan, noted that sometimes it is challenging for him to articulate some ideas in Russian or Kazakh languages, in particular during job interviews:

> We want to say something but are not able to do it. We use English terms, employers do not understand us. It looks like we show off using English, but in fact we simply do not know how say it in Russian. (Chemical engineering graduate)

With regard to *written communication skills,* interview participants appeared to be highly satisfied with how well their skills were developed after graduation. Graduate participant 7:

> There was a communication department, so we had courses. In my first year, I had a course where we learnt some basic things: how to write emails, professional correspondence, create resume, cover letter. It was one of the most useful courses. (Computer science graduate)

Graduate participant 8:

> At the university we wrote lab reports, papers. We were taught how to write anything, e.g. introduction, background, conclusion and how to create a flow, so parts logically follow each other from introduction to background, and so on. And these papers were assessed very seriously, so we developed this skill how to write emails, technical projects, so on. (Electrical and electronic engineering graduate)

The majority of graduate participants were found to be generally satisfied with their *working well in a team* skill. They mainly commented on group projects that were frequently assigned by their professors. Even though they as students did not always understand the purpose of group projects and experienced a lot of difficulties when working with partners, they believe that because of those projects now they feel confident when working in a team at work. Graduate participant 7:

> We had to work together, build relationships. Sometimes schedules are different, so you have to negotiate. I noticed that in my first year, it was very difficult, I tried to do everything myself. But eventually got used and [accepted that] I needed to be able to do it. You start seeing that two minds are better, so I think my teamwork skills are well-developed because of the university. (Computer science graduate)

However, graduate participant 2 noticed that teamwork at the university is different from what it is at workplace and nowadays he experiences difficulties. While students just share responsibilities, they and also professors do no not think about how students interact with each other, what roles they assign to each other, and so on. Thus, he believes that more attention should be paid to the organization and assessment of group projects.

In line with the survey's results, employers believe that graduates possess well-developed *Communication and Cooperation* skills. As for communication skills, all employer participants noticed that graduates are quite good at expressing their opinion, giving presentations, and generally making good impression on people. However, as employer participant 2 noted, graduates tend to use English words when speaking Russian or Kazakh especially when it comes to specific terms, so sometimes it creates misunderstanding and might irritate their colleagues. This situation might cause difficulties for communication among team members and consequently put success of company's projects under threat.

Knowledge-related skills. Similarly to the survey's results, graduates participating in the interviews expressed quite high satisfaction with their *research skills* after graduation. The main factors which helped graduates to develop these skills are specific courses, laboratory projects and opportunities to work with professors on research projects. Graduate participants 1 and 2, both engineering graduates, mentioned having opportunities of working with professors on research projects. Thus, graduate participant 7 noted that they had a course devoted to developing research skills: "We had a course where we studied the format of research papers. We read a lot about research" (computer science graduate). However, she also

stressed that for her former group mates and for her personally it would be better if the program had more applied courses: “We did not have a course on algorithms, even though tech companies expect to see these skills, practical skills” (graduate participant 7). Graduate participant 2 also noted that there is imbalance between research and applied dimensions. Thus, qualitative findings support the survey’s results which showed that with regard to *research skills* satisfaction mean is higher than importance mean, in case of graduates’ perceptions.

Thus, this study shows that graduates and employers are mainly satisfied with how well graduates’ skills are developed after graduation. However, some gaps between importance and satisfaction were found. Thus, in both survey and interviews, graduates indicated that *Field-Specific Knowledge and Skills* have to be improved. The main reasons are failure to balance theory and practice and neglect of local market realities. As for employers, they generally seem to be less critical toward graduates’ *Specific Knowledge and Skills*, however they believe that graduates’ *Methodological Skills* could be developed better, specifically with regard to *working without close supervision, ability to solve problems* and *ability to work under pressure*. In interviews, it emerged that employers tend to believe that graduates have unrealistic expectations toward workplace and generally the life outside campus.

The Role of Universities, Employers and Students in Developing Students’ Skills

In relation to the third research question, participants were asked to evaluate the importance of the role of different actors, namely student, university and employer, in developing students’ skills using a 5-point Likert Scale where 1= not important, 2= of little importance, 3= neutral, 4= important, 5= very important. Table 16 illustrates the views of university graduates and employers participating in the online survey.

Table 16

The Importance of the Role of Student, University and Employer in Developing Students' Skills

	Graduates		Employers	
Variable	Mean	SD	Mean	SD
Student	4.67	0.589	4.37	.831
University	4.21	0.761	4.47	.513
Employer	4.06	0.867	4.11	.875

According to the graduates, students themselves play the most important role in developing their skills, followed by university and employer. On the other hand, employers ranked the role of university slightly higher than the role of students, but, similarly to graduates, ranked the role of employer as the least important. It should be noted that no differences were found when the data was analyzed by major, employment status, or gender - in case of graduates - and ownership type, industry, or company size - in case of employers.

University role. None of graduates participating in the interviews expected that the university would fully equip them for their future careers. While they did criticize the program for some deficiencies in their knowledge and skills, they still believed that students themselves are responsible for their learning progress. Two participants even noted that it would be impossible for a Bachelor's program to cover in detail all possible branches of a discipline. As graduate participant 9 explained, "I realized that the university does not teach so I memorize everything, but it teaches me to think as an engineer. It develops engineering thinking, analytical thinking, so I can solve tasks and problem rather quickly". In a broader perspective, graduate participant 6 mentioned that higher education has affected his mindset:

> Before the university, I thought differently. I had only subjective opinions and I believed in them. I could not stand alternative views, I did not even think they existed. The university taught to check any opinion from different angles. All pros and cons

> should be considered. This is what we call ‘evidence’. It changes mindset and a person’s approach toward work. (Chemical engineering graduate)

Acknowledging the primary role of a student, graduates believe that the university’s main responsibility is to provide students with positive environment and opportunities, both academic and extracurricular, to develop personally and professionally. Thus, all participants acknowledged the importance of availability of social clubs, research projects, and sports activities for developing generic skills. As graduate participant 7, computer science graduate, noted:

> Communication and organizational skills helped me at work when I had to organize a meeting for people from different countries. … It was very similar to how we organized tournaments at the university, and people from different cities came to debate tournaments. It helped a lot. (Computer science graduate)

Furthermore, as a part of the university environment, peer-to-peer influence has been mentioned by two participants to be a positive factor which assisted in developing and improving their skills. Thus, graduate participant 6 mentioned that being surrounded by hard-working group mates made him rethink his attitude toward learning process and motivation, and consequently improve his learning skills, “I was always envious of those who could learn from the morning till evening. I could not understand where they got motivation and strength. But somehow I learned from them and developed this skill”. It is important to mention that the university which has been chosen for this study has a very competitive selection process and quite high performance requirements, so students studying there indeed seem to be very motivated to demonstrate excellent results. As for extracurricular activities, graduate participant 1 stated that because of the university’s dynamic, busy, atmosphere where every student seemed to be constantly working on something, e.g. research projects or social events, even those students who were naturally passive or introverted got infected by that culture and peers’ examples, and also started to take part in different initiatives. Therefore, peer-to-peer

relationship seems to be a part of positive university environment which encourages students to learn new skills. In this case, the university plays an important role in selecting motivated students, so they can learn and support each other in acquiring new knowledge and skills.

Another area mentioned by the participants, specifically female graduates, providing students with psychological support. As graduate participant 7 explained:

> I know a lot of people with stress, especially during exams. And it [psychological counseling] is definitely support from the university. We always had it, but at some moments we needed more of that. If we had had more opportunities, workshops, psychologists it would have been in demand – such psychological support. (Computer science graduate)

Interestingly, two participants noticed that it is also important for universities to be flexible and provide students with options, e. g. elective courses or choice of internship provider, so they can make their own choice and influence the process. As participant 5, electrical engineer, explained, universities should encourage and even teach students to be able to make choices themselves and be conscious about all aspects of their education and in a broader perspective their lives.

With regards to career management, graduates expected that the university would help them to connect with job market and get better understanding of what employers in their industry require from fresh graduates in terms of knowledge and skills. Students stressed the importance of university-business partnership, including internships, job fairs, guest lectures with industry professionals, etc. Thus assistance in finding a company for internship, organizing meeting with companies representatives and career counseling were mentioned frequently during interviews. Graduate participant 8 also mentioned networking as a valuable asset universities provide students with. Meeting with employers at events organized by the university and having a chance to communicate with professors on campus, in case of students

who consider pursuing academic career, is of high importance for students and fresh graduates.

Another aspect mentioned during interviews by one of the graduates was boost of self-confidence once education is finished. Graduate participant 6 stressed that the fact of belonging to of the best universities in the country influences graduates' further career and life decisions, the way they communicate with people and their self-esteem.

Employers interviewed for this study emphasized that they do not expect that universities would teach students all skills, especially practical skills, required for performing specific jobs. However, they do expect that universities would equip students with theoretical subject knowledge and internships opportunities, "The main responsibility of a university is to equip students with theoretical knowledge. With regard to practical skills, universities can only provide students with an opportunity to take an internship and then everything depends on a student" (employer participant 1).The role of universities in supporting graduates in finding employment opportunities has been mentioned by several employer participants. Employer participant 1 stressed the importance of good relationships between universities and employers. Specifically, as a human resources manager she pointed out that some universities do seem to be interested enough in employment opportunities for their graduates. When their company offers vacancies suitable for fresh graduates, some universities do not respond in a timely manner or decide to put off such matters and consequently might lose such opportunities.

Student role. Graduates participating in the interviews emphasized personal responsibility of students for acquiring new knowledge and developing skills. All interview participants seem to believe that while university provides learning environment with opportunities for personal and professional growth, students themselves have to take initiative

and use these opportunities. Thus, motivation to learn and self-discipline have been frequently mentioned by participants as students' major input into their professional development at the university. On the other hand, laziness, lack of discipline and failure to balance studies and social life appeared to be the most frequently mentioned intrinsic factors which prevent students from being successful in learning process, including skill development. Also, some participants mentioned that they wished they had spent more time studying and thinking about their career perspectives while being students.

Several participants described the process of pursing higher education as a chance to get exposed to different ideas and experiences and eventually understand what each of them wants to do with their career path and overall with their life. Volunteering, extracurricular activities and internships have been mentioned as useful practices in acquiring generic skills, understanding personal preferences and 'finding' yourself. Therefore students believe that they have to be active and open-minded in order to create a picture of what they like and what they want to achieve. As graduate participant 1 explained, "You need to put yourself into different situations, clubs. It is like a trial to see what you like. … You have four years to find yourself". However, two participants mentioned that they expected from the university some guidance in related matters. However, graduate participant 2, a mechanical engineer, noted that not only being provided with opportunities to learn and develop, but also being aware of such opportunities and having clear understanding of how to use them also matters, though sometimes neglected:

> We have a lot of opportunities but these opportunities are not always realized because the information about them is not conveyed to students in the right way. … Everything depends on a student. But it is impossible to understand what you need without professors, program, and structure. (Mechanical engineering graduate)

Similarly, graduate participant 6 pointed out that universities have to provide students with a general picture of what professionals in their field do, so in case a student realizes it is not suitable for him or her, they can change a major right after the first year when it is not too late.

With regards to a student's role, employers mainly commented on two aspects such as development of generic skills and initiative during internships. Employers and graduates in this study share a view that students themselves play the main role in developing generic skills. While discussing generic skills, employers mainly referred to them as something personal, and not necessarily acquired but in some cases naturally inherited (for example, being introverted or extraverted). Therefore, they did not expect universities to teach students generic skills and placed the responsibility of that solely on students. In case of internships, employers described the role of a student as defining, meaning that success of internships mainly depend on students' initiative and interest. While universities offer a possibility of doing internship in different organizations, employers stressed that the choice and the result depend only on a student's motivation. As employer participant 3 explained:

> Students should take it [internship] seriously. It is a good chance to leave a comfort zone and experience real life. They need to take on any tasks, projects, and so on. It depends on them personally if they get something from it or not. (Human resources manager, oil and gas)

Employer role. With regards to the role of an employer, both groups of participants, namely employers and graduates, believe that employers should take on an active role in developing students' skills. During in-depth interviews they mainly commented on different forms of university-industry partnership, such as internships and curriculum development, mentorship of novice professionals who have recently graduated and the level of development of the industry.

Employers participating in the study believe that businesses can and should take part in developing students' skills. Employer participant 1 criticized those companies which perceive themselves to be at the highest position on the job market and believe that universities and students have to serve their needs:

> If companies need job ready professionals, they have to interact [with universities] and not wait everything from universities. Many companies wait for a ready 'product'. But if you do not invest yourself .. As you sow, so shall you reap. (Human resources manager, construction and engineering company)

Employer participants noted that their companies are ready to teach fresh graduates practical skills and support them during adaptation period. Employer participant 2, "We give priority to young professionals and close eyes to the lack of some competencies … We raise them. We believe that it is easier to create rather than to retrain professionals".

When discussing interaction between universities and employers, graduates perceived it as mutually-beneficial partnership. According to the graduates, employers receive a lot of benefits when helping students in their development, including promotion of employer brand, a chance to select the best potential employees and quickly 'adjust' them for the company's needs and culture. Thus, several participants seemed to be quite frustrated when discussing their personal experiences of interacting with employers, for example of being interns, as it could be much more beneficial for both parties. University graduates stressed that they expected employers not only to provide students with internships but also to support them during the process. Some participants mentioned that while being interns they did not feel that the company was interested in their development, so they were mainly assigned administrative work and did not have a chance to learn much about field-specific aspects. As graduate participant 5 explained:

> I cannot talk about all companies, but some of them are not really interested in their interns. Some take them [interns] in order to cover the responsibilities posed by the

> society. It is like, see: we invest in young people. (Electrical and electronic engineering graduate)

As for employers, all participants noted that their companies provide students with internships and see it as an effective instrument of how businesses can contribute to developing students' skills. However, in relation to students' criticism of lack of attention toward them during internships, employer participant 1 mentioned that the duration of a typical internship does not allow their company to assign students with more comprehensive tasks. All three employer respondents believe that organizing longer internships might be a solution. As for curriculum development, several participants noted that it would be highly beneficial for both universities and employers if programs were created in partnership with industry representatives. The former would have a competitive program and consequently satisfied students, whereas the latter would have better prepared workforce in the future.

Overall, it can be seen that development of students' skills is a complex process and all actors, such as university, students and employers actively contribute to this process and their roles are highly interconnected. Generally, graduates who participated in this study see the role of university in providing students with opportunities for professional and personal development. Importantly, they stress that students themselves have to be active and motivated to use these opportunities, both academic and extracurricular, and therefore students play the most important role in this process. Even though, graduates criticized university for some deficiencies in their knowledge and skills, they still felt that student role was defining. On the other hand, employers seem to place more importance on university. It might be explained by the fact that organizations deal with hundreds or even thousands of university graduates every year and therefore they might pay less attention to individual cases and more to the overall level of graduates' job readiness in the country. The role of employers is perceived to be less important by both groups, though interview participants mentioned several aspects, such as

internships, job fairs, etc. where employers play a substantial role. It should be also noted here that employers who participated in the study seemed to be enthusiastic with regard to partnering with universities and did not sound as passive ‘recipients’ but active participants of the process.

Chapter 5. Discussion

This chapter presents the interpretation of the findings in relation to previous studies into STEM graduates' skill sets and the role of universities, students and employers in students' development.

Similar to studies conducted in both developed and developing countries, the findings of this study confirm the high importance of generic skills for STEM graduates. Employers and graduates in this study placed great emphasis on the skills which are useful across industries and jobs, such as problem-solving skills, ability to work in a team, communication skills, etc. The findings can be explained by the situation on the labor market in the country. In Kazakhstan, university graduates constantly face challenges with finding a job due to the limited employment opportunities. Understanding this, graduates highly value generic skills, which are easily transferable and applicable in different areas of business, allow employees to try different positions, adjust quickly, and even to change a career if needed. So while graduates still perceive field-specific knowledge and skills to be of substantial importance, they ranked the importance of generic skills higher. As for employers, while they acknowledge the limitations of universities in developing students' field-specific skills and the fact that graduates have very limited work experience, do not expect graduates to show excellence in this area and are ready to teach them technical skills which are missing. However, they do expect graduates to have at least broad understanding of their subject. Thus, employers seek for graduates who have well-developed generic skills, are eager to learn and possess good basic knowledge of their subject. Having said that, learning skills which were not included into the survey but emerged during interviews, appeared to be one of the most important skills perceived by both graduates and employers in line with the previous studies (Coll & Zegwaard, 2006; Nair et al., 2009). Also, in line with previous studies (Nair et al.,

2009; Peng et al., 2016), management skills were found to be perceived as one of the least important skills by employers.

The findings also show that there is a room for improvement in STEM graduates' skill sets in Kazakhstan. Thus, similarly to Peng et al. (2016), graduates in this study are the least satisfied with field-specific knowledge and skills, highlighting the importance of bridging the gaps between higher education and employment prospects. The underlying reasons for this are inconsistencies in a program's structure and content, neglect of local market realities and theory-practice imbalance. In particular, engineering graduates of this study pointed out that their Bachelor's programs mainly did not take into account the realities of local industries, such as equipment and manufacturing standards inherited from Soviet period, and instead focused on the western markets. The findings indicate that while universities in Kazakhstan are adopting international approaches of education and put efforts into preparing globally competitive graduates, there is a risk to move too far from local economic realities. Therefore this study argues that for Kazakhstani higher education it is important to keep a well-balanced mix of global and local and bring changes to higher education gradually and in accordance with local economy. Furthermore, the results suggest that there is a need to include more applied learning activities and tasks related to real-business issues and cases. While participants of this study did not claim that the only role of pursuing higher education is obtaining employment, they do believe that universities need to support graduates in transiting from university to workplace as entering the labor market is next logical step. With regard to generic skills, graduates appeared to be mainly satisfied with these skills, highlighting the role of extracurricular and social activities in developing such skills. On the other hand, employers in this study appeared to be mainly satisfied with graduates' field-specific knowledge and, contrary to Ramadi et al. (2016) , Peng et al. (2016), and Nair et al. (2009), with graduates'

communication skills. However, employers see the biggest gaps in graduates' *ability to work under pressure*, *capacity to work without close supervision*, *ability to solve problems* and *getting on well with others in the workplace*. Employer participants suggest that while graduates spend substantial amount of time in academic environment, they tend to have unrealistic and often romanticized expectations of how the world of work operates. Therefore it takes graduates time to adjust to real life problems and new organizational culture. These findings imply that there is a need to increase partnership between universities and industries, so students have more opportunities to take internships, communicate with professionals, and generally get exposed to work environment.

In relation to the role of universities, students and employers in developing students' skills, the findings support the previous studies and suggest that students' development is a shared responsibility. Similarly to the study conducted by Tholen (2019), neither graduates nor employers placed the whole responsibility on university even though gaps between acquired and required skills were revealed. Participants of this study took into account universities' limited resources, the students' role in learning process and importance of partnerships with employers. In this study both graduates and employers believe that in order to ensure graduates' success in the workplace, all stakeholders should actively contribute to the process. However, while the study conducted by Tran (2015) revealed that employers, graduates and students share the same view with regard to the responsibility of university for how well students' skills are developed, in this study graduates and employers' perceptions of the importance of the role of these actors differ. Thus, graduates ranked the role of students as the most important one, followed by the role of university, whereas the employers placed more importance on university than student. Furthermore, the role of employers is perceived as less important than the role of university and students and mainly limited to internships and career

events on campus. The findings are similar to the study conducted by Archer and Davison (2008) and Sin and Amaral (2017) that show that the role of employer is usually very limited and mainly deals with providing internships and argue that employers should play a bigger role in developing students' skills. Also, Alpay and Jones (2012) argue that there is a need to rethink and expand the benefits employers gain from partnering with universities regarding student education. Therefore this study argues that all stakeholders play an important role in students' development, and cooperation has to be increased through better employer engagement.

Chapter 6. Conclusion

This study explored employers and graduates' perceptions regarding STEM graduates' skill sets in Kazakhstan. The key research questions that guided the study are:

- What are the most important skills perceived by STEM graduates and those expected by employers?
- To what extent are employers satisfied with skills possessed by graduates and how do graduates themselves assess their skills attained at university?
- What are graduates and employers' perceptions of the role of universities, students and employers in developing students' skills?

In this study, a convergent mixed methods design was employed. Data were collected from recent STEM graduates and their employers at one university in Kazakhstan.

The findings suggest that both graduates and employers place high importance on generic skills, in particular *ability to solve problems, working well in a team, ability to work under pressure, getting on well with others in the workplace,* and *ability to learn quickly*. The study also revealed gaps between graduates' required and acquired skills. Thus, graduates appeared to be mainly dissatisfied with their field-specific knowledge and skills, whereas employers are mainly dissatisfied with graduates' *capacity to work without close supervision, ability to work under pressure, ability to solve problems* and *getting on well with others in the workplace*. With regard to the third research question, the findings show that university, student and employer are all active participants in the process of developing students' skills.

Limitations

This study intended to contribute to the discussion about STEM graduates' skill sets in Kazakhstan. It should be noted that the study has several limitations. Firstly, graduate

participants of this study come from one single university, so the findings cannot be generalized to all STEM graduates in the country. Additionally, physics graduates did not take part in this study as well as graduates of social science fields which also does not allow generalizing the findings to the whole population of university graduates of the chosen university. Secondly, while the contacts of the participants were obtained through the university's database, some were reached through snowball sampling which is a nonprobability technique. Thirdly, the number of employers participating in this study is quite small, and consequently the choice of statistical analysis tools was limited; the same is true for participants of in-depth interviews.

Despite the limitations, this study provides valuable insights about STEM graduates' skill sets in Kazakhstan and contributes to better understanding of the role of universities, students and employers in students' development. In order to minimize the limitations, several measures have been implemented. Firstly, graduates who participated in the online survey and in-depth interviews represent diverse majors, cohorts, genders, and occupations. Also, employers who participated in the study represent various industries and have substantial experience of working with recent university graduates. Thus, the study brings variety of perceptions and experiences of both graduate and employer participants. Secondly, non-parametric tests were employed when analyzing quantitative data so that unequal sizes of two groups, namely employers and graduates, and non-normal distribution of data were taken into account when making conclusions.

Research Implications, Recommendations and Future Research Directions

Based on the findings of the present study, several implications can be drawn for university authorities, employers, recent graduates, and current students.

Firstly, perceptions of employers and graduates regarding the required skill sets for STEM novice professionals are quite well aligned and demonstrate the increasing importance of generic skills in addition to field-specific knowledge and skills. Thus, universities need to be aware of the existing requirements and pay attention not only to transferring theoretical knowledge but also supporting students in developing skills. At the same time, students themselves might need to consider pursuing university education as a chance to develop skills which can be applied in the future.

Secondly, the study has revealed that there is a room for improvement in STEM graduates' skill sets. One of the main causes of the perceived deficiencies is significant distance between academic environment and workplace realities. Therefore, it indicates that more should be done to foster university-industry partnership. In this regard, universities might expand the employer engagement through inviting industry professionals to participate in curricula design and teaching. Furthermore, changes to curricula might be introduced so that students are offered more applied courses and encouraged to work on real-world cases and tasks.

Thirdly, students and recent graduates need to acknowledge that it is their responsibility to be proactive about their personal and professional development and be eager to constantly acquire new knowledge and skills. Furthermore, universities need to provide various opportunities for students to develop their skills through both academic and extracurricular activities and strengthen the relationships with industries. The role of employers in developing students' skills is perceived to be less important than other stakeholders and might need to be extended. Participants of the study, both graduates and employers, stated that the duration of internships need be extended in order to allow students to get more work-related experience and interact closely with employers.

Future research can compare experiences of graduates from several universities to identify if there are differences in graduates' perceptions across public and state universities. Future study can also look at experiences of graduates across social science and STEM fields and compare their perceptions with regard to the required and acquired skills.

Personal Reflection

I believe that working on the thesis helped me to improve my critical thinking, analytical, negotiating and writing skills. I am happy that I was not afraid of conducting mixed methods research, because I had a chance to apply all the knowledge I received at GSE. Being a researcher is a journey, sometimes challenging, but always exciting.

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Appendices

Appendix A

INFORMED CONSENT FORM
(Online survey - graduates)

DESCRIPTION: You are invited to participate in research study entitled *"***Required and Acquired Skills in STEM: Comparing Employers and Graduates' Perceptions in Kazakhstan***"*. This research project is being conducted by Yevgeniya Serkova, a student at Graduate School of Education, Nazarbayev University. You will be asked to evaluate the importance of skills for your career, assess how well your skills were developed after graduation from the university, and indicate who is responsible for developing university students' skills.

TIME INVOLVEMENT: Your participation will take approximately 10 minutes to complete.

RISKS AND BENEFITS: The risks associated with this research are minimal. One possible risk of this study is discomfort that university graduates might feel while assessing their skills after graduation. Participants might be unwilling to reveal their weaknesses and therefore, overstate their skills. In order to minimize this risk, participants will be introduced to the written consent form which indicates that the data obtained through this study will remain confidential and anonymous. This study is hoped to shed new light on the issue of graduates' skill sets and employability in Kazakhstan. It is expected to provide university authorities with useful insights, so they are able to improve their academic programs.

PARTICIPANT'S RIGHTS: If you have read this form and have decided to participate in this project, please understand your participation is voluntary and you have the right to withdraw your consent or discontinue participation at any time without penalty or loss of benefits to which you are otherwise entitled. The alternative is not to participate. You have the right to refuse to answer particular questions. The results of this research study may be presented at scientific or professional meetings or published in scientific journals.

CONTACT INFORMATION:

Questions: If you have any questions, concerns or complaints about this research, its procedures, risks and benefits, contact the Master's Thesis Supervisor for this student work, Dilrabo Jonbekova at dilrabo.jonbekova@nu.edu.kz or the author of the study Yevgeniya Serkova at yevgeniya.serkova@nu.edu.kz .

Independent Contact: If you are not satisfied with how this study is being conducted, or if you have any concerns, complaints, or general questions about the research or your rights as a participant, please contact the NUGSE Research Committee to at gse_researchcommittee@nu.edu.kz

Please press *Agree* button 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.

You can print and sign a copy of this consent form to keep for yourself.

According to the law of the Republic of Kazakhstan an individual under the age of 18 is considered a child. Any participant falling into that category should be given the Parental Consent Form and have it signed by at least one of his/her parent(s) or guardian(s).

Appendix B

INFORMED CONSENT FORM
(Online survey – employers)

DESCRIPTION: You are invited to participate in research study entitled *"***Required and Acquired Skills in STEM: Comparing Employers and Graduates' Perceptions in Kazakhstan***"*. This research project is being conducted by Yevgeniya Serkova, a student at Graduate School of Education, Nazarbayev University. You will be asked about important skills for STEM university graduates' career, evaluate how well graduates' skills are developed after graduation, and indicate who is responsible for developing university students' soft skills.

TIME INVOLVEMENT: Your participation will take approximately 10 minutes to complete.

RISKS AND BENEFITS: The risks associated with this research are minimal. One possible risk of this study is discomfort that employers might feel while assessing their employees' skills. Participants might be unwilling to reveal the employees' weaknesses and therefore, overstate their skills. In order to minimize this risk, participants will be introduced to the written consent form which indicates that the data obtained through this study will remain confidential and anonymous. This study is hoped to shed new light on the issue of graduates' skills sets and employability in Kazakhstan. It is expected to provide university authorities with useful insights, so they are able to improve their academic programs.

PARTICIPANT'S RIGHTS: If you have read this form and have decided to participate in this project, please understand your participation is voluntary and you have the right to withdraw your consent or discontinue participation at any time without penalty or loss of benefits to which you are otherwise entitled. The alternative is not to participate. You have the right to refuse to answer particular questions. The results of this research study may be presented at scientific or professional meetings or published in scientific journals.

CONTACT INFORMATION:

Questions: If you have any questions, concerns or complaints about this research, its procedures, risks and benefits, contact the Master's Thesis Supervisor for this student work, Dilrabo Jonbekova at dilrabo.jonbekova@nu.edu.kz or the author of the study Yevgeniya Serkova at yevgeniya.serkova@nu.edu.kz .

Independent Contact: If you are not satisfied with how this study is being conducted, or if you have any concerns, complaints, or general questions about the research or your rights as a participant, please contact the NUGSE Research Committee to at gse_researchcommittee@nu.edu.kz
Please sign this consent from 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.

Signature: _____ Date: _____

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

According to the law of the Republic of Kazakhstan an individual under the age of 18 is considered a child. Any participant falling into that category should be given the Parental Consent Form and have it signed by at least one of his/her parent(s) or guardian(s).

Appendix C

INFORMED CONSENT FORM
(Interview – graduates)

DESCRIPTION: You are invited to participate in research study entitled *"***Required and Acquired Skills in STEM: Comparing Employers and Graduates' Perceptions in Kazakhstan***"*. This research project is being conducted by Yevgeniya Serkova, a student at Graduate School of Education, Nazarbayev University. You will be asked to evaluate the importance of skills for your career, assess how well your skills were developed after graduation from the university, and indicate who is responsible for developing university students' skills.

TIME INVOLVEMENT: Your participation will take approximately 30 minutes to complete.

RISKS AND BENEFITS: The risks associated with this research are minimal. One possible risk of this study is discomfort that university graduates might feel while assessing their skills after graduation. Participants might be unwilling to reveal their weaknesses and therefore, overstate their skills. In order to minimize this risk, participants will be introduced to the written consent form which indicates that the data obtained through this study will remain confidential and anonymous. This study is hoped to shed new light on the issue of graduates' skill sets and employability in Kazakhstan. It is expected to provide university authorities with useful insights, so they are able to improve their academic programs.

PARTICIPANT'S RIGHTS: If you have read this form and have decided to participate in this project, please understand your participation is voluntary and you have the right to withdraw your consent or discontinue participation at any time without penalty or loss of benefits to which you are otherwise entitled. The alternative is not to participate. You have the right to refuse to answer particular questions. The results of this research study may be presented at scientific or professional meetings or published in scientific journals.

CONTACT INFORMATION:

Questions: If you have any questions, concerns or complaints about this research, its procedures, risks and benefits, contact the Master's Thesis Supervisor for this student work, [].

Independent Contact: If you are not satisfied with how this study is being conducted, or if you have any concerns, complaints, or general questions about the research or your rights as a participant, please contact the NUGSE Research Committee to at gse_researchcommittee@nu.edu.kz
Please sign this consent from 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.

Signature: _____ Date: _____

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

According to the law of the Republic of Kazakhstan an individual under the age of 18 is considered a child. Any participant falling into that category should be given the Parental Consent Form and have it signed by at least one of his/her parent(s) or guardian(s).

Appendix D

INFORMED CONSENT FORM
(Interview - employers)

DESCRIPTION: You are invited to participate in research study entitled *"***Required and Acquired Skills in STEM: Comparing Employers and Graduates' Perceptions in Kazakhstan***"*. This research project is being conducted by Yevgeniya Serkova, a student at Graduate School of Education, Nazarbayev University. You will be asked about important skills for STEM university graduates' career, evaluate how well graduates' skills are developed after graduation, and indicate who is responsible for developing university students' soft skills.

TIME INVOLVEMENT: Your participation will take approximately 30 minutes to complete.

RISKS AND BENEFITS: The risks associated with this research are minimal. One possible risk of this study is discomfort that employers might feel while assessing their employees' skills. Participants might be unwilling to reveal the employees' weaknesses and therefore, overstate their skills. In order to minimize this risk, participants will be introduced to the written consent form which indicates that the data obtained through this study will remain confidential and anonymous. This study is hoped to shed new light on the issue of graduates' skills sets and employability in Kazakhstan. It is expected to provide university authorities with useful insights, so they are able to improve their academic programs.

PARTICIPANT'S RIGHTS: If you have read this form and have decided to participate in this project, please understand your participation is voluntary and you have the right to withdraw your consent or discontinue participation at any time without penalty or loss of benefits to which you are otherwise entitled. The alternative is not to participate. You have the right to refuse to answer particular questions. The results of this research study may be presented at scientific or professional meetings or published in scientific journals.

CONTACT INFORMATION:

Questions: If you have any questions, concerns or complaints about this research, its procedures, risks and benefits, contact the Master's Thesis Supervisor for this student work, Dilrabo Jonbekova at dilrabo.jonbekova@nu.edu.kz or the author of the study Yevgeniya Serkova at yevgeniya.serkova@nu.edu.kz .

Independent Contact: If you are not satisfied with how this study is being conducted, or if you have any concerns, complaints, or general questions about the research or your rights as a participant, please contact the NUGSE Research Committee to at gse_researchcommittee@nu.edu.kz
Please sign this consent from 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.

Signature: _____ Date: _____

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

According to the law of the Republic of Kazakhstan an individual under the age of 18 is considered a child. Any participant falling into that category should be given the Parental Consent Form and have it signed by at least one of his/her parent(s) or guardian(s).

Appendix E

INTERVIEW PROTOCOL
(Graduates)

Hello. My name is Yevgeniya, I am a Masters student at Graduate School of Education. Nice to meet you. Thank you for agreeing to participate in the study "**Required and Acquired Skills in STEM: Comparing Employers and Graduates' Perceptions in Kazakhstan**". The purpose of this study is to explore graduates and employers' perceptions about STEM graduates' skills in Kazakhstan.

Participation in this study is voluntary. You have the right to skip any particular question if you are not willing to answer for any reason.

Please, read and sign a Consent form. Do you mind recording our interview?

Questions:

General:

- What year did you graduate from [] university? What was your major?
- Do you work now? Where?
- What are your key responsibilities?

RQ1:

- What are the most important skills for your career?
- Why these skills?

RQ2:

- In your opinion, how well were you prepared for a job after graduating from the university? Why?
- Can you provide examples when you demonstrated excellent skills and when you experienced difficulties due to the lack of some skills at your work?

RQ3:

- What is the role of universities in developing students' skills? What is the role of students? What is the role of employers?
- What can universities do for better developing students' skills?

Is there anything else you would love to tell me? Thank you for your time!

Appendix F

INTERVIEW PROTOCOL
(Employers)

Hello. My name is Yevgeniya, I am a Masters student at Graduate School of Education. Nice to meet you. Thank you for agreeing to participate in the study "**Required and Acquired Skills in STEM: Comparing Employers and Graduates' Perceptions in Kazakhstan**". The purpose of this study is to explore graduates and employers' perceptions about STEM graduates' skills in Kazakhstan.

Participation in this study is voluntary. You have the right to skip any particular question if you are not willing to answer for any reason.

Please, read and sign a Consent form. Do you mind recording our interview?

Questions:

General:

- What company do you work for? How long have you been working here?
- Tell me about key your responsibilities.
- What is your experience in working with recent graduates from [] university?

RQ1:

- What are the most important skills for STEM university graduates?
- Why these skills?

RQ2:

- In your opinion, how well are [] university graduates prepared for a job? Why?
- Can you provide examples when they demonstrated excellent skills and when they experienced difficulties due to the lack of some skills?
- What can universities do for better developing students' skills?

RQ3:

- What is the role of universities in developing students' skills?
- What is the role of students?
- What is the role of employers?

Is there anything else you would love to tell me? Thank you for your time!

Appendix G

SURVEY QUESTIONS
(Graduates)

Q1. (Graduates)1. Based on your experience, how important are the following skills for STEM university graduates to get employed?

	Not important (1)	Of little importance (2)	Neutral (3)	Important (4)	Very important (5)
Possess relevant field-specific theoretical knowledge (1)	○	○	○	○	○
Possess relevant field-specific technical skills (2)	○	○	○	○	○
Ability to apply professional knowledge and skills to job tasks (3)	○	○	○	○	○
Possess broad general knowledge (4)	○	○	○	○	○
Oral communication skills (5)	○	○	○	○	○
Written communication skills (6)	○	○	○	○	○
Using modern technology effectively (7)	○	○	○	○	○
Research skills (8)	○	○	○	○	○
Working well in a team (9)	○	○	○	○	○
Getting on well with others in the workplace (10)	○	○	○	○	○
Ability to interact with co-workers from different or multi-cultural backgrounds (11)	○	○	○	○	○
Management skills (12)	○	○	○	○	○
Ability to solve problems (13)	○	○	○	○	○

Ability to work under pressure (14)	○	○	○	○	○
Ability to develop innovative ideas (15)	○	○	○	○	○
Capacity to work without close supervision (16)	○	○	○	○	○
Demonstrating leadership skills (17)	○	○	○	○	○
Demonstrating ethical standards (18)	○	○	○	○	○

Q2. In your opinion, how well were your skills developed after graduating from [] University with a Bachelor's degree?

	Very poor (1)	Poor (2)	Average (3)	Good (4)	Excellent (5)
Possess relevant field-specific theoretical knowledge (1)	○	○	○	○	○
Possess relevant field-specific technical skills (2)	○	○	○	○	○
Ability to apply professional knowledge and skills to job tasks (3)	○	○	○	○	○
Possess broad general knowledge (4)	○	○	○	○	○
Oral communication skills (5)	○	○	○	○	○
Written communication skills (6)	○	○	○	○	○
Using modern technology effectively (7)	○	○	○	○	○
Research skills (8)	○	○	○	○	○
Working well in a team (9)	○	○	○	○	○
Getting on well with others in the workplace (10)	○	○	○	○	○
Ability to interact with co-workers from different or multi-cultural backgrounds (11)	○	○	○	○	○

Management skills (12)	○	○	○	○	○
Ability to solve problems (13)	○	○	○	○	○
Ability to work under pressure (14)	○	○	○	○	○
Ability to develop innovative ideas (15)	○	○	○	○	○
Capacity to work without close supervision (16)	○	○	○	○	○
Demonstrating leadership skills (17)	○	○	○	○	○
Demonstrating ethical standards (18)	○	○	○	○	○

Q3. In your opinion, how important is the role of the following actors in developing students' skills?

	Not important (1)	Of little importance (2)	Neutral (3)	Important (4)	Very important (5)
Student (1)	○	○	○	○	○
University (2)	○	○	○	○	○
Employer (3)	○	○	○	○	○

Q4. Please, indicate your gender

- ○ Male
- ○ Female

Q5. What year did you graduate from [] University with a Bachelor's degree?

- ○ 2016
- ○ 2017
- ○ 2018
- ○ Other

Q6. What was your major?
- Biological Sciences
- Chemical Engineering
- Chemistry
- Civil Engineering
- Computer Science
- Electrical and Electronic Engineering
- Mathematics
- Mechanical Engineering
- Physics
- Robotics and Mechatronics
- Other

Q7. What is your current employment status?
- Full-time employed
- Part-time employed
- Self-employed
- Not employed; looking for a job
- Not employed; not looking for a job
- Pursuing further education

Q8. What industry do you work in?
- Agriculture
- Consulting
- Construction
- Education & Science
- Energy
- Finance
- Government and Public Administration
- Information Technologies
- Healthcare
- Manufacturing & Production
- Mining & Oil and Gas
- Telecommunications
- Transportation
- Other

Q9. If you would like to take part in follow-up interviews, please, provide your email:

Appendix H

Survey questions
(Employers)

Q1. Based on your experience, how important are the following skills for STEM university graduates to get employed by your company?

	Not important (1)	Of little importance (2)	Neutral (3)	Important (4)	Very important (5)
Possess relevant field-specific theoretical knowledge (1)	○	○	○	○	○
Possess relevant field-specific technical skills (2)	○	○	○	○	○
Ability to apply professional knowledge and skills to job tasks (3)	○	○	○	○	○
Possess broad general knowledge (4)	○	○	○	○	○
Oral communication skills (5)	○	○	○	○	○
Written communication skills (6)	○	○	○	○	○
Using modern technology effectively (7)	○	○	○	○	○
Research skills (8)	○	○	○	○	○
Working well in a team (9)	○	○	○	○	○
Getting on well with others in the workplace (10)	○	○	○	○	○
Ability to interact with co-workers from different or multi-cultural backgrounds (11)	○	○	○	○	○
Management skills (12)	○	○	○	○	○
Ability to solve problems (13)	○	○	○	○	○

Ability to work under pressure (14)	○	○	○	○	○
Ability to develop innovative ideas (15)	○	○	○	○	○
Capacity to work without close supervision (16)	○	○	○	○	○
Demonstrating leadership skills (17)	○	○	○	○	○
Demonstrating ethical standards (18)	○	○	○	○	○

Q2 To what extent are you satisfied with [] University STEM graduates' skills?

	Very dissatisfied (1)	Dissatisfied (2)	Neutral (3)	Satisfied (4)	Very satisfied (5)
Possess relevant field-specific theoretical knowledge (1)	○	○	○	○	○
Possess relevant field-specific technical skills (2)	○	○	○	○	○
Ability to apply professional knowledge and skills to job tasks (3)	○	○	○	○	○
Possess broad general knowledge (4)	○	○	○	○	○
Oral communication skills (5)	○	○	○	○	○
Written communication skills (6)	○	○	○	○	○
Using modern technology effectively (7)	○	○	○	○	○
Research skills (8)	○	○	○	○	○
Working well in a team (9)	○	○	○	○	○
Getting on well with others in the workplace (10)	○	○	○	○	○

Ability to interact with co-workers from different or multi-cultural backgrounds (11)	○	○	○	○	○
Management skills (12)	○	○	○	○	○
Ability to solve problems (13)	○	○	○	○	○
Ability to work under pressure (14)	○	○	○	○	○
Ability to develop innovative ideas (15)	○	○	○	○	○
Capacity to work without close supervision (16)	○	○	○	○	○
Demonstrating leadership skills (17)	○	○	○	○	○
Demonstrating ethical standards (18)	○	○	○	○	○

Q3 In your opinion, how important is the role of the following actors in developing students' skills?

	Not important (1)	Of little importance (2)	Neutral (3)	Important (4)	Very important (5)
Student (1)	○	○	○	○	○
University (2)	○	○	○	○	○
Employer (3)	○	○	○	○	○

Q4 What industry does your company work in?

- ○ Agriculture
- ○ Consulting
- ○ Construction
- ○ Education & Science
- ○ Energy
- ○ Finance
- ○ Government and Public Administration
- ○ Information Technologies
- ○ Healthcare
- ○ Manufacturing & Production

- Mining & Oil and Gas
- Telecommunications
- Transportation
- Other

Q5 What is the size of your company?

- Fewer than 100
- 100-499
- 500-999
- 1000 and more

Q11 Please, indicate the ownership of your company:

- Public
- Private
- Other

Q8 If you would like to take part in follow-up interviews, please, provide your email:

Appendix I

INTERVIEW TRANSCRIPT EXAMPLE

Transcript	Codes
развитие бизнеса с ключ клиентами по [], визиты на заводы клиентов, активы, обнаружение проблем, чем помочь, какие решения предложить, внедрение систем чтобы к прост бизнес проц, автоматизир ,... полностью ведение бизнеса с клиентами которых мы считаем ключевыми .. По шкале 1-10 на 4. Те природа моей нынешней работы.. например связана с инженер.. но допустим я очень плохо знаю оборудование хотя я инж механик... у нас в универе в инженерии нет специализации как допустим в обыч вузах.. в кз или росссиии... те то чему готовят в обычных вузах это наболее специализир чем то что дают в ... мы должны выходить универс.. но мы выходим но можно сказать знаем очень очень ... не то чтобы мало.. недостаточно... очень недостаточно.. я считаю.. этому конечно можно научиться. но это база знания об оборудовании.. как выглядит .. как работает.... культура практики производ.. никак не налажена... универ это дает. на 8 из 10. у нас не так много внимания уделяется именно в учебном процессе таким лиддершип скилс... или но это проф салес скилс... но навыки коммуникации. презентаций тот же английский в универе я оценил на 8 из 10...не хватило лидер.. они развиваются если ты хочешь сам.. какие то дебатные клубы, тост мастеры.. это экстра кур активитис... но не в учебной программе	Equipment Field-specific skills Internships Communication skills Extracurricular activities
учился и работал там.. всё говорю на и инженерном факультете... я замечал это и за другими... во первых программа не согласована.. то что мы проходим на 1 пр.. мы можем через 2 года повторить на др.. проходить параллельно на .. прогр не поставлены.. нет системы.. нет четкого плана.. как будто на тяп ляп.. потом практики их студенты не должны искать сами.. те если хотят в определенную компа то да.. но ну должен предоставлять больше возможностей.. налаживать связи заводами компаниями.. где студенты могут пройти практику не то что пришел посмотрел .. бумажки переносил.. а пришел познакомился с оборудованием.. сделал расчеты.. те же диплом проекты.. тезис на мастерс... я бы хотел чтобы это бы не что-то внутри универа. а именно как по модели в германии, Росиии.. пишешь дипломку ты берешь конкретное оборудование .. представляешь решения по улучшению.. что-то такое..	Program inconsistencies Internships

Transcript	Codes
налаживать связи с компаниями которые ... не обязательно передовые но которые даю такой необходимый опыт .. про стем говорим... то у нас очень мало таких коллабораций индустрией с представителями индустрии.. очень ресеч базед.. я бы сказал это фокус очень однобокий.. я не против ресч.. но я против только ресеч... это все зависит.. я сам занимался исследовательской деятельностью... на сколько помогла... не сказал бы что помогла именно сейчас в работе.. если я продолжу... помогла когда я поступал на мастер пчд.. опять же зависит от интересов.. если ресеч.. то важно.. но когда я работал та я звал студентов работать над ресеч если интересно нужно... но я считаю что эти навыки полезны именно если ты ост в академии	Partnership between university and industry Research skills
нужно уметь распределять роли в команде.. у меня с этим сейчас проблемы.. я не всегда понимаю роль если мне ее не разъяснят.. те нужно уметь правильно ставить задачи.. распределить ресурсы.. опять же претензии к учеб программе.. предмет проджект менеджмент.. это была куча теории без наглядных примеров как это применяется на практике.. хотя кажется проджект менеджер это самая популярная сейчас профессия... можно да кейсы.. проекты.. реал кейсы с компаний это идеал.. я не ждал на курсе.. но какие-то навыки те примеры из реал жизни необходимы.. хотя бы просто гест спикер не просто профессор кот читает лекции..	Teamwork Real cases to study
да в любом случае все зависит от студента.. все что тебе нужно если ты знаешь что тебе нужно.. но узнать что тебе нужно нельзя без профессора программы структуры системной.. и вот..	Student role

Appendix J

CODES AND THEMES

Subject specific skills
Subject specific skills required
Subject specific skills acquired

Generic skills
Generic skills required (general)
Generic skills acquired (general)
Leadership skills
Communication skills
Presentation skills
Teamwork
Learning skills
Quick adaptation
Problem solving
Management skills
Research skills

Factors which influence development of students' skills
Program itself (organization, content)
Role of faculty
Peer-to-peer influence
Organizational culture
Bureaucracy
Equipment at university
Laboratory projects
International, not Kazakhstani standards
Terminology in English language
Internships
Real cases to study
Lack of understanding why some subjects are taught
Impact of secondary education
Lack of understanding what professionals in their fields do
Presentations as assignments
Freedom to choose subjects

University's role in developing students' skills
Creating environment
Creating awareness of opportunities
Partnership between university and industry

Students' role in developing students' skills
Inner motivation to learn
Participation in research projects

Participation in extracurricular activities

Employers' role in developing students' skills
Partnership between university and industry
Finding potential employees
Mentorship
Internships