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About the Need to Attract Girls to Education Using the Stem Methodology in the Informatics Educational Program

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***Abstract*—The article considered the need to promote women in education along the path of STEM (science, technology, engineering and mathematics). Nowadays, more and more women are working in male-dominated fields. While STEM is still dominated by men, and there is an increase in women in education [1]. Based on this, statistical data on the choice of an educational program (EP) "Informatics" along the STEM trajectory by men and women after secondary education were studied. Based on the data received from the departments to which (EP) informatics belongs, data from 6 universities of Kazakhstan were requested.**

The sample consisted of students enrolled in the informatics educational program from the 1st to the 4th year. To study this, we used a quantitative analysis method, thanks to which we found that women are much more likely to choose a pedagogical direction than men. Our results show that an environment with gender-normative ideas pushes women to get STEM education more often than men. To this end, we are considering the issue of informatics along the STEM trajectory, as well as the creation of additional sections to the content of professional disciplines taught in the EP "Informatics". This textbook is intended for students of pedagogical universities preparing future teachers of informatics in secondary schools.

Keywords—STEM; gender; women; men; methods; education; universities.

I. INTRODUCTION

In the world, teachers are faced with the task of educating students who are able to solve increasingly complex tasks. In recent years, demands have been put forward in the fields of science, technology, engineering and mathematics, which should be based solely on the creation of interdisciplinary connections, conducting deeper research. In addition to the subject being studied, the science, technology, engineering and mathematics (STEM) methodology can become a potentially useful tool in solving this problem. One of the tasks of our university is to improve the STEM methodology, which has become mandatory for future STEM-based informatics teachers.

STEM is currently a method of comprehensive teaching of several mutually related subjects. Our goal is to create additional sections to the content of professional disciplines and to improve the methodology of its teaching.

Currently, the most highly paid professions are characteristic of the field of information technology, where the gender imbalance is most pronounced. Foreign analysis of the gender composition of personnel in the industries included in the standard STEM system shows that the number of women among specialists is only 24%. According to researchers, all over the world, women who have a university degree in a specialty included in the standard STEM set, more often than their male colleagues prefer to work not by profession, but in education or healthcare Women in technical professions, 2015).

STEM covers a wide range of professions, including web developers and software application developers, computer programmers, research scientists, architects, engineers, database administrators, technicians, mathematicians, informatics and many others.

The proportion of women in STEM jobs, especially in highly skilled jobs, remains low. The gender gap begins already at the level of higher education: according to UNESCO, women make up only 35 percent of students studying fields of knowledge from the STEM set [1].

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A decrease in the proportion of women in industries requiring specialized technical knowledge and skills that are highly paid and for which demand is growing may exacerbate gender inequality [2].

Countries that have so far focused their efforts on overcoming the shortage of personnel in the STEM sector and focused on the involvement of girls and women in STEM professions are trying to develop effective measures to eliminate gender inequality in the digital economy.

"Increasing the number of women in STEM and protecting them at the most basic level is a matter of fairness. Women should have the same opportunities as men to choose, follow and achieve success in a STEM career. It is also part of the efforts that trade unions must step up in an effort to become more inclusive and diverse and adapt to a changing world in order to survive in it. With the development of new technologies and the Fourth Industrial Revolution, a critical moment is coming for trade unions and the need to act urgently to protect women in STEM," said Walter SANCHEZ, General Secretary of Industry ALL [3].

From the above analysis, the following questions arise, which are considered in this study:

the need to attract women as future informatics teachers to the STEM trajectory;

- to identify the importance of women's employment after graduation in this field.
- to determine the quantitative indicators of men and women in 6 universities of Kazakhstan.
- Universities and research organizations need special measures to help keep women in the STEM trajectory.

II. LITERATURE REVIEW

Men and women are still concentrated in different fields of education. Men are more likely to be engaged in gender-stereotypical male fields, such as science or technology, whereas women are more likely to be engaged in gender-stereotypical female fields, such as language or humanities (Organization for Economic Cooperation and Development [OECD], 2009a) [4].

This unequal distribution of men and women across fields of education leads to gender-based professional careers and contributes to gender income inequality (Smith & Steinmetz, 2008). These gender differences in educational choice are present not only when entering higher education institutions (Mann & DiPrete, 2013), but also in early adolescence, when men are more likely to choose male-dominated trajectories, and women are more likely to choose female-dominated trajectories in secondary education (Van Langen et al., 2008; Van der Fluten and others 2016).

Women have made tremendous strides in higher education and in the labor market. However, women are still underrepresented in fields related to science, technology, engineering and mathematics (STEM) (Charles & Bradley, 2009; Mann & DiPrete, 2013). The tendency of women to drop STEM directions during their educational and professional careers has been called a “leaky pipeline” (Mann & DiPrete, 2013; Morgan, Gelbgiser, & Weeden, 2013; Riegle-Crumb, King, Grodsky, & Muller, 2012). Moreover, many talented women miss out on the higher professional status and earnings offered by STEM careers (Hill, Corbett and Rose, 2010; Reimer and Steinmetz, 2009).

Gender ideology can influence educational choices by influencing how men and women assess their competence in a particular field (Correll2004; Wigfield and Eccles 2000). Studies show that, according to traditional gender norms, men are more confident in their abilities in mathematics or science than women (Correll2004; Crombie et al. 2005; Sikora and Pokropek 2012), who often assess their competence in reading, language and social activities or teaching more positively (Chow and Salmela-Aro 2011; Jacobs et al., 2002) [5]. Despite the recent increase in the number of women in higher education, men and women are still concentrated in various educational programs and professions (Barone 2011; Gerber and Cheung 2008). This gender segregation is the result of persistent gender differences in the choice of education, which leads to different educational opportunities and prospects in the labor market. (Charles and Bradley 2009; Pinksten et al. 2012; Van Langen, Rekers-Mombarg and Dekkers 2006, 2008) [6].

In many countries, women even outperform men in areas related to male gender stereotypes, such as informatics in secondary education (OECD, 2009b).

Over the years, the burden on teachers has increased, especially in the content areas of STEM courses, as they seek to meet the needs of a more diverse range of students who are expected to meet and even surpass local, state and national standards [5].

Explanations of gender differences in STEM majors have traditionally focused on academic performance and abilities, but numerous studies show that the gender gap in STEM cannot be explained solely by such differences (Ceci, Williams, & Barnett, 2009; Hyde, Lindberg, Linn, Ellis, & Williams, 2008; Mann & DiPrete, 2013).

III. METHODS

In order to achieve the growth of women in STEM education, it is necessary to create and ensure profitable conditions for women's work and career growth.

Based on the data received from the departments to which the informatics educational program belongs, data from 6 universities of Kazakhstan were requested.

For the study and identification, statistical data on the educational program (EP) "Informatics" in the STEM trajectory for training were considered. Based on this, the following were used:

- data were collected among students from the 1st to the 4th year in 6 universities of the country.
- a method of comparative quantitative analysis, with the help of which gender equality is revealed;
- quantitative indicators of future informatics teachers along the STEM trajectory.

The choice of universities is justified by the fact that these universities study (EP) "Informatics" for both men and women. Among them are 3 national universities - KazNPU (Abai Kazakh National Pedagogical University), KazNU (al–Farabi Kazakh National University), ENU (Gumilev Eurasian National University) and 3 state universities - Zhetysu (I. Zhansugurov Zhetysu University), Pavlodar (Pavlodar State University), Kyzylorda (Korkyt Ata Kyzylorda University).

The main goal is to study the gender equality of the contingent of future informatics teachers along the STEM trajectory.

The sample was selected in 4 stages in accordance with the condition of the presence of EP at the university, which was stratified according to the level of education and the percentage of students in higher education institutions. Universities were selected with a probability proportional to their size and the number of state-funded grants under the EP, using the number of students at the appropriate educational level (Fig. 1).

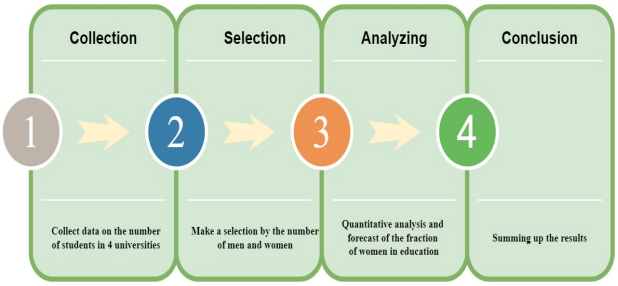

Figure 1. Stages of data sampling for research.

IV. Results

In this study, the role of gender equality in universities in the specialty of Informatics in the direction of education in the STEM trajectory was studied.

The study took into account the number of grants allocated and the number of students studying in this specialty. The study focused on students enrolled in the STEM trajectory education program, that is, on men and women who, after graduation, will be informatics teachers in the STEM trajectory, in the secondary education system. This allowed us to better understand the possible reasons for dropping out of STEM based on gender while continuing education. Using the data that were selected, 6 universities of Kazakhstan were analyzed by the number of men and women studying in the Informatics program.

In total, 1007 students were included in our analysis, of which 402 were boys and 605 were women, a time schedule was used to demonstrate the gender difference in the Informatics EP at selected universities in Kazakhstan (Fig-2 and Fig-3).

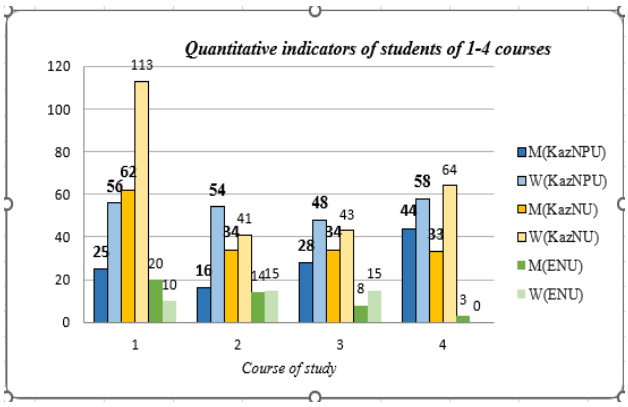

Figure 2. Quantitative indicators of male and female students in the EP «Informatics» (national universities)

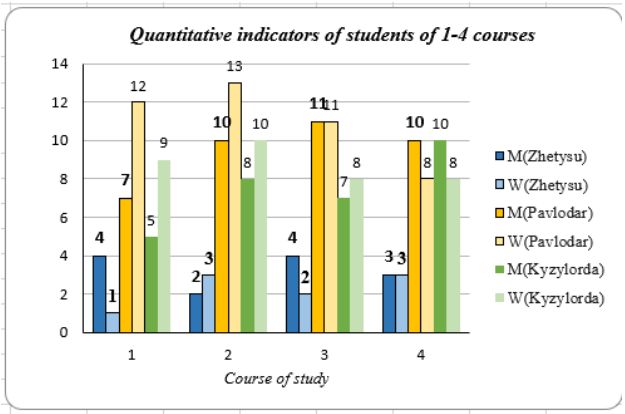

Figure 3. Quantitative indicators of male and female students in the EP «Informatics» (state universities)

And also, in order to show how gender stereotypical, the areas of study are, the percentage of man and woman students studying in the EP at universities from 2019/2020 to 2022/2023 was calculated. Thus, a higher score indicates a more gender-stereotypical field of study for both men and women. According to our data, in the field of higher education in the field of Informatics in the field of higher education in the field of Informatics in the STEM trajectory, the highest percentage are women (55.19%), and men (44.81%).

This chart shows that the gender gap is quite large. Women were on average 10,38% percentage point more likely than men to enter the field of education along the STEM trajectory (Fig-4).

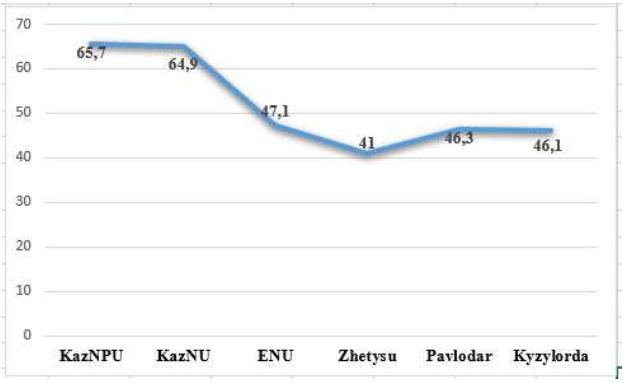

Figure 4. Share of women studying in the EP «Informatics» in 6 universities of Kazakhstan

V. Discussion

Despite the fact that the number of employees has steadily increased over the past few years, there is still a significant decrease in women directly in STEM fields (for example, mathematics, natural and applied sciences, technology).

To eliminate this lack of representation, numerous educational strategies and corporate initiatives, especially in the recent past, have been aimed at increasing women's enthusiasm for STEM activities and professions, especially in education [7].

The main attention in this study is paid to students from the 1st to the 4th courses of higher educational institutions in four universities of Kazakhstan. At the end of the fourth year of higher education at the age of 20-21,

Kazakhstani students of the specialty "Informatics" choose one of several trajectories related to the profession, which differ in the intensity of application of STEM computer science: computer science in teaching or computer science in industry [9].

Computer science in teaching is the most intensive computer science, followed by science, education, programming, graphic design, web development, etc. Choosing such a trajectory in STEM has significant implications for the future educational career of graduates, since it allows you to link various fields and sections related to computer science. For example, students can study starting with “what is a computer?” and ending with “project development" [4].

Currently, the transition to the fourth industrial revolution is taking place in the developed countries of the world, new breakthroughs are being made in the fields of artificial intelligence, robotics, autonomous transport, nanotechnology, virtual reality and quantum computers, which are more or less related to computer science. The new technological paradigm opens up unprecedented opportunities and prospects, but at the same time leads to new social challenges and risks associated primarily with the transformation of the labor market [Fourth Industrial Revolution, 2018] [8]. Therefore, right now it is necessary to devote time and conditions for the growth of women in areas where STEM is used. After all, the presence of a woman can always be a plus rather than a minus.

VI. Conclusions

Higher education institutions play an important role in reducing the gender gap in education, as they have an impact before, during and after higher education.

When studying, in research, or performing any project in the direction of STEM, it is quite possible that there will be a need to think not only from the point of view of men, but also women. For example, research may be necessary in cases where a person should feel like the object of a woman's research [10].

In this article, the issue of gender equality in the EP "Informatics" along the STEM trajectory in 6 universities of Kazakhstan was considered. As a result of the analysis, it turned out that the percentage of women studying in the field of Informatics is significantly higher than that of men. Thanks to the results of the study, it became known that in the direction of STEM, the presence of not only men, but also women is very important. It is also necessary to fully interact on equal terms and create conditions for choosing this trajectory [2].

In conclusion, according to the results of the study, it turned out that more and more conditions are being created for more and more women to choose a direction along the STEM trajectory and develop in this area.

From the above analysis, the following tasks were achieved:

- the question of the need to involve women in STEM education;
- the importance of equal employment of women is determined;
- the percentage of growth of women in informatics in 6 universities of Kazakhstan was revealed. Since they will be able to contribute to the development of this area, including education. Due to this, when preparing future informatics teachers in the STEM trajectory, it is necessary to take into account personnel characteristics and competencies related to them.

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