Computer science students' self-assessment of their skills - a survey study

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ABSTRACT: Skills self-assessment allows students to identify and reflect on their strengths and weaknesses leading to improved performance. In this research, the authors examine computer science graduates' self-assessment of skills. The quantitative method was chosen for this study and included 120 graduates from different regions of Kazakhstan. The study aimed at self-assessing the skills of graduates, the correlation between hard and soft skills, and differences based on region and gender. The results show that graduates have a high level of confidence, that there is some correlation in skills and no difference in assessment in regard to region. However, contrary to previous studies, female graduates demonstrate higher confidence than males in their skills. The results of this research can be used to decrease the level of student dropout in computer science, leading to a better level of preparation and attitude among graduates entering the labour market.

INTRODUCTION

The 21st century labour market is changing due to the development of artificial intelligence and automation, and the employment situation has changed with a significant shift in the requirements for skills. Previously, employers paid little attention to soft skills, and the requirements for them were much lower. Now the importance of *soft skills* has increased, pointing out that 10 of the 16 key skills are considered *soft* in the 21st century [1].

Skill is *the ability to use one's knowledge effectively and readily in execution or performance* [2]. People generally distinguish between two types of skills: the first type, known as hard skills, consists of essential knowledge and know-how skills. The second type of skills pertains to social skills and soft skills, which are defined as behavioural skills [3].

In addition, employers are looking for engineers who not only have technical knowledge but also know how to work well in teams, communicate effectively and demonstrate leadership potential. Therefore, to succeed in today's rapidly changing and globalised workplace, engineers must be able to effectively collaborate with colleagues from different backgrounds and cultures, transfer technical information to a non-technical audience, and adapt to changing circumstances and technologies [4].

Student self-assessment is a form of authentic assessment in which each student reflects on her/his strengths and weaknesses to identify learning needs especially in regard to the identified weaknesses to improve achievement and/or performance [5]. Student self-assessment has several advantages, such as:

a) enhancing students' awareness of their learning and thinking processes;
b) developing appropriate study skills and strategies and fostering lifelong learning;
c) promoting learners' autonomy and bringing a sense of responsibility to them;
d) stimulating learners to consider course content critically and helping them achieve a high level of academic thinking skills.

However, at the same time, there are some drawbacks, including:

a) students tend to view themselves in desirable ways;
b) many students believe that the duty of assessment is the responsibility of the teacher;
c) there may be a mismatch between the goals of assessment by the learner and the teacher [6].

Students, particularly females, frequently experience a lack of motivation due to the perceived difficulty of the subject and comparisons with their peers. The interplay of self-concept and utility value significantly influences students'

decisions to continue or discontinue their studies [7]. One of the reasons students drop out of university is due to low self-esteem in their skills. Self-assessment of abilities is a strong indicator of perseverance, as individuals must believe they possess sufficient skills in a given field to pursue a career in that field [8]. Many publications about women around the world refer to female self-doubt and also show that women underestimate their skills even when there is no skills difference in regard to men [9].

Despite the recognised popularity of computer science studies, student self-assessment, its impact on performance and dropout levels, and students' perceptions about their skills and attitudes depending on the region in Kazakhstan remain relatively unexplored. Hence, this research aims to address the following questions:

RQ1: What are the self-assessed hard and soft skills among computer science graduates in Kazakhstan?
RQ2: Are there correlations in self-assessments of skills among computer science graduates?
RQ2: Are there regional and gender differences in self-assessments of skills among computer science graduates?

METHODOLOGY

This quantitative study examined the self-assessment of the hard and soft skills of computer science graduates. The purpose of the study was to determine how graduates assess their skills within their specialty. The results obtained can help in the development or modification of training programmes and methods aimed at improving skills, the effectiveness of the learning process and better preparation for the labour market.

Tool Development

The research questionnaire contained questions about the soft and hard skills of computer science graduates who rated them on a 5-point Likert scale (1 - very low, 2 - low, 3 - medium, 4 - high and 5 - very high). The list of soft and hard skills was formed in the process of literature review and examination of current vacancies on the labour market. During the preparation of the questionnaire, the questions were discussed with experts, during which some questions were changed or deleted. Feedback was also received during the pilot experiment, which also helped to improve the questionnaire by changing the wording and order of the questions.

Data Collection

One-hundred twenty computer science graduates from eight regions of Kazakhstan participated in this study. The questionnaire was developed in Google Forms and distributed via social media. Participation in the study was voluntary, where confidentiality and anonymity of the participants were ensured. All research protocols were approved by the Ethics Committee of the Kazakh National Women's Teacher Training University before the commencement of the study. Jamovi statistical computer program was used for data analysis.

Limitations

The self-reported nature of the hard and soft assessment used in this research may not accurately reflect the students' actual abilities. Due to the limited sample size, there is a potential for response bias. Therefore, a more representative sample is required to facilitate a more in-depth investigation.

RESULTS AND DISCUSSION

The majority of the respondents were females - 80% (n = 96), from Almaty - 69.1% (n = 83), whereas respondents from other regions made up a minority. The part of the questionnaire on self-assessment of graduates' skills consisted of 38 items, with 18 items on hard skills, and 20 items on soft skills. The value of the Cronbach's alpha coefficient for this part of the questionnaire was $\alpha = 0.971$.

Description Analysis

For the primary analysis, descriptive statistics were calculated (mean, median, standard deviation and frequencies). Tables 1a and Table 1b show the results listed from highest to lowest. The highest scoring item among hard skills was *algorithmisation and data structuring* (3.88), and the lowest scoring item in this category was *working in development methodologies* (2.92). In regard to soft skills, the highest scoring item was *reliability* (4.17), and the lowest scoring item in this category was *business skills* (3.73).

Table 1a: Statistical summary of hard skills self-assessment.

Hard skills	1	2	3	4	5	Mean	SD	Median
Algorithmisation and data structurisation	2	6	26	57	29	3.88	0.894	4
Network administration	2	6	32	55	25	3.79	0.888	4

Software development	1	9	28	60	22	3.77	0.864	4
Programming (different languages)	1	8	30	62	19	3.75	0.833	4
Working with databases and servers	0	11	31	60	18	3.71	0.834	4
Cloud computing	0	11	39	53	17	3.63	0.84	4
Technical support	1	12	43	45	19	3.58	0.904	4
Products versions managing	2	11	43	47	17	3.55	0.906	4
Monitoring and statistics	1	13	42	47	17	3.55	0.897	4
English skills	2	7	49	50	12	3.52	0.82	4
Understanding others' code	2	8	53	41	16	3.51	0.87	3
Cybersecurity	3	11	46	44	16	3.49	0.926	3.5
Products testing	4	13	41	44	18	3.49	0.987	4
Operating systems (Linux, MacOS, etc)	6	12	37	47	18	3.49	1.029	4
Product support and maintenance	6	10	46	45	13	3.41	0.966	3
Blockchain development	10	16	48	35	11	3.17	1.051	3
Modelling tools	12	17	43	36	12	3.16	1.108	3
Working in development methodologies	22	18	37	33	10	2.92	1.224	3

Table 1b: Statistical summary of soft skills self-assessment.

Soft skills	1	2	3	4	5	Mean	SD	Median
Reliability	0	3	19	53	45	4.17	1	4
Communication	1	2	15	60	42	4.17	1	4
Purposefulness	1	4	13	60	42	4.15	1	4
Self-study	0	5	17	56	42	4.13	1	4
Honesty	2	4	19	46	49	4.13	1	5
Teamwork	0	6	18	52	44	4.12	1	4
Getting the job done	0	2	22	56	40	4.12	1	4
Presentation	0	4	17	63	36	4.09	1	4
Creativity	1	4	18	62	35	4.05	1	4
Negotiation skills	2	2	25	59	32	3.98	1	4
Quickly assimilating information	0	4	25	63	28	3.96	0	4
Attentiveness	0	4	25	65	26	3.94	0	4
Analytical thinking	0	4	26	65	25	3.92	0.25	4
Problem solving	0	3	32	62	23	3.88	1	4
Adaptability	0	6	30	57	27	3.88	1	4
Multitasking	1	4	29	61	25	3.88	1	4
Teaching	2	4	27	62	25	3.87	1	4
Time management	0	10	25	58	27	3.85	1	4
Idea generation	1	7	24	65	23	3.85	1	4
Business skills	2	12	25	59	22	3.73	1	4

The means were interpreted from *no ability or confidence* to *excellent ability or confidence* in skill (Table 2) [10].

Table 2: Qualitative interpretation of 5-point Likert scale measurements.

Likert scale	Interval	Difference	Description
1	1.00-1.79	0.79	No ability or confidence in this skill
2	1.80-2.59	0.79	Minimal ability or confidence in this skill
3	2.60-3.39	0.79	Average ability or confidence in this skill
4	3.40-4.19	0.79	Solid ability or confidence in this skill
5	4.20-5.00	0.80	Excellent ability or confidence in this skill

As shown in Table 2, the differential value of each interval is identical, thus ensuring uniformity across all intervals. Therefore, looking at Table 1a and Table 1b above, it can be seen that the mean in hard and soft skills is between 2.92 and 4.17, which is indicative of average and solid ability.

Correlation Analysis

A Spearman's correlation was conducted to evaluate the relationship between students' hard skills and soft skills. There was a significant positive relationship in students' self-assessment between some hard and soft skills.

A significant positive correlation means that as students rate themselves higher in one skill, they also tend to rate themselves higher in another. For example, students who believe they are good at problem solving also tend to believe they are good at technical support, and vice versa. Table 3 presents the correlation coefficients, which are more than 0.6 and significant at the level of 0.01, which implies a strong correlation level between the self-assessment of students' hard and soft skills.

Table 3: Correlation matrix between hard and soft skills.

		Problem solving	Analytical thinking
Product support and maintenance	Spearman's rho	0.692*	0.541
	df	118	118
	p-value	< 0.001	< 0.001
Products testing	Spearman's rho	0.636*	0.445
	df	118	118
	p-value	< 0.001	< 0.001
Monitoring and statistics	Spearman's rho	0.769*	0.583
	df	118	118
	p-value	< 0.001	< 0.001
Technical support	Spearman's rho	0.763*	0.624*
	df	118	118
	p-value	< 0.001	< 0.001

Note: *means a strong correlation, where the correlation coefficient is more than 0.6. The first column includes hard skills and the first row - soft

Comparative Analysis

Mann-Whitney *U* test was performed to compare skills between graduates: a) who studied in Almaty (n = 83) and those who studied in other regions (n = 37); and b) between women (n = 96) and men (n = 24). The null hypothesis for both comparisons assumed no significant differences existed in the self-assessment of skills based on region and gender.

The result indicated that there was no significant difference ($p > 0.05$) in the self-assessment of hard and soft skills between the two groups based on region. This suggests that the region of study (Almaty city *vs* other regions) did not have a statistically significant impact on how graduates evaluated their skills. Therefore, the null hypothesis was accepted. Almaty is compared with other regions because it is one of the biggest cities in Kazakhstan and attracts a significant number of students from other regions, making it the leader in both the number of higher education institutions (HEIs) and the number of students.

The assessment result based on gender was surprising, as it showed a significant difference in the self-assessment of hard and soft skills between women and men, as demonstrated in Table 4a and Table 4b. Therefore, in this case, the null hypothesis was rejected. Female students were significantly more confident than male students in their self-assessment of eight hard skills and three soft skills, as seen by the mean in the Tables below.

Table 4a: Mann-Whitney *U* test results for self-assessment of hard skills - differences between females and males.

Mann-Whitney *U* test						
	Group	N	Mean	Statistic	*p*	Effect size
Algorithmisation and data structures	Female	96	3.99	739	0.004	0.359
	Male	24	3.42			
Network administration	Female	96	3.90	824	0.022	0.285
	Male	24	3.38			
Working with databases and servers	Female	96	3.81	776	0.008	0.326
	Male	24	3.29			
Blockchain development	Female	96	3.33	646	< 0.001	0.439
	Male	24	2.54			

Cloud computing	Female	96	3.75	741	0.004	0.357
	Male	24	3.17			
Operating systems (Linux, MacOS, etc)	Female	96	3.64	709	0.002	0.385
	Male	24	2.92			
Working in development methodologies	Female	96	3.13	617	< 0.001	0.465
	Male	24	2.13			
Modelling tools	Female	96	3.28	782	0.011	0.322
	Male	24	2.67			
Note: $H_a\ \mu_1 \neq \mu_2$						

Table 4b: Mann-Whitney *U* test results for self-assessment of soft skills - differences between females and males.

Mann-Whitney *U* test						
	Group	N	Mean	Statistic	*p*	Effect size
Business skills	Female	96	3.82	796	0.012	0.309
	Male	24	3.33			
Presentation skills	Female	96	4.17	849	0.029	0.263
	Male	24	3.79			
Idea generation	Female	96	4.13	831	0.021	0.279
	Male	24	3.75			
Note: $H_a\ \mu_1 \neq \mu_2$						

DISCUSSION

The first research question of the study referred to how computer science graduates evaluate their hard and soft skills. The research findings suggest that graduates are more confident in their soft skills than in their hard skills. Self-evaluation is one of the main processes in self-regulation, and it refers to the individual's assessment of his/her performance [11]. It can be considered that students' attitude toward their skills is more often positive than negative.

The second research question was about the correlation between self-assessment of hard skills and soft skills. Previous studies have found correlations between hard and soft skills, and in the present case, the researchers also determined a strong positive relationship between problem-solving skills and product support and maintenance, products testing, monitoring and statistics, and technical support skills; and analytical thinking skills correlated with technical support skills [12]. The problem-solving ability is one of the most important student skills in the 21st century. It is usually considered an important part of the engineering design process, but it is often neglected in the classroom [13]. A lot of scientists regard problem-solving skills as one of the most important learning elements to help students adapt to the learning and working environment [14].

Analytical thinking is also very important, and analytical skills are one of the higher-order thinking skills that have been the focus of educational goals in recent ages [15]. Their correlation with technical support skills can be explained by the fact that technical support in many cases needs analytical and critical thinking to solve the problem.

The last question was to compare the difference in self-assessment of skills between Almaty city graduates and graduates from other regions, and the difference between females and males. The study did not find any differences in students' self-assessments of any skills based on region. However, there are differences in self-assessment of eight hard and three soft skills between females and males. The interesting fact is that earlier researchers pointed out that girls tend to underestimate their performance in comparison with boys [16]. Similar studies conducted in other fields showed that boys tend to overestimate their achievements, whereas girls generally tend to underestimate their performance [17]. But in the present case, the results were opposite, indicating that women were more confident than men in their skills.

CONCLUSIONS

This work contributes to the field of computing education by demonstrating the self-assessment of graduates' skills in computer science in Kazakhstan, the correlation between hard and soft skills, and the differences in self-assessment based on region and gender. The findings demonstrate that graduates have high confidence in their skills, suggesting a generally positive attitude toward their field of study. Previous studies indicated that girls tend to underestimate their skills relative to boys, but the present results showed that female graduates reported higher self-assessments in some hard skills and soft skills. This suggests a shift in perception among women in computer science, pointing out that they may be recognising and validating their capabilities more confidently than in the past, as indicated in earlier studies. Taking into account the above factors, teachers and stakeholders can use the findings of this study to improve educational processes and appropriately support computer science students.

REFERENCES

1. Ramalingam, H., Usmani, R.S.A., Hashem, I.A.T. and Pillai, T.R., A hybrid model to profile and evaluate soft skills of computing graduates for employment. *Inter. J. of Advanced Computer Science and Applications*, 12, **7**, 529-536 (2021).
2. Merriam-Webster. Skill. In Merriam-Webster.com Dictionary. 10 October 2024. https://www.merriam-webster.com/dictionary/skill
3. Ibourk, A. and El Aynaoui, K., Trajectories of higher education graduates: impact of soft skills. *Economies*, 11, **7**, 198 (2023).
4. Kavanagh, M.H. and Drennan, L., What skills and attributes does an accounting graduate need? Evidence from student perceptions and employer expectations. *Accounting & Finance*. 48, **2**, 279-300 (2008).
5. Fitzpatrick, J., Self-assessment as a strategy to provoke integrative learning within a professional degree programme. *Learning in Health and Social Care*, 5, **1**, 23-34 (2006).
6. El-Koumy, A., Student Self-Assessment in Higher Education: Alone or Plus? Educ. Resources Infor. Center (ERIC), USA (2010).
7. Oscarson, M., *Self-assessment of Foreign and Second Language Proficiency*. Encyclopaedia of Language and Education. 7, 175-187 (1997).
8. Barr, M. and Kallia, M., Why students drop computing science: using models of motivation to understand student attrition and retention. *Proc. 22nd Koli Calling Inter. Conf. on Comp. Educ. Research*, 1-6 (2022).
9. Lishinski, A., Yadav, A., Good, J. and Enbody, R., Learning to program: gender differences and interactive effects of students' motivation, goals, and self-efficacy on performance. *Proc. 2016 ACM Conf. on Inter. Comp. Educ. Research*, 211-220 (2016).
10. Pimentel, J.L., A note on the usage of Likert Scaling for research data analysis. *USM R&D J.*, 18, **2,** 109-112 (2010).
11. Ramdass, D. and Zimmerman, B.J., Effects of self-correction strategy training on middle school students' self-efficacy, self-evaluation, and mathematics division learning. *J. of Advanced Academics*, *20*, **1**, 18-41 (2008).
12. Putri, D.P., The correlation of soft skills and hard skills to learning outcomes of mathematics students. *Tarbawi: Jurnal Ilmu Pendidikan*, 17, **1**, 83-93 (2021).
13. Yi, L., Improving university second-year students' problem-solving skills in computer science course (digital logic course) through engineering design process in Inner Mongolia. *J. of Educ. and Educational Research*, 7, **2**, 5-11 (2024).
14. Xiao, F., Examining Problem-Solving Skills in Technology-Rich Environments as Related to Numeracy. Doctoral Dissertation (2016).
15. Mayarni, M. and Nopiyanti. E., Critical and analytical thinking skill in ecology learning: a correlational study. *Jurnal Pendidikan Biologi Indonesia*, 7, **1**, 63-70 (2021).
16. Hunt, C., Yoder, S., Comment, T., Price, T., Akram, B., Battestilli, L., Barnes, T. and Fisk, S., Gender, self-assessment, and persistence in computing: how gender differences in self-assessed ability reduce women's persistence in computer science. *Proc. 2022 ACM Conf. on Inter. Comp. Educ. Research*, 73-83 (2022).
17. Quille, K., Culligan, N. and Bergin, S., Insights on gender differences in cs1: a multi-institutional, multi-variate study. *Proc. 2017 ACM Conf. on Innov. and Tech. in Comp. Science Educ.*, 263-268 (2017).