Social Factors Influence on Career Choices for Female Computer Science Students

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Abstract—The low and shrinking numbers of female students studying computer science is a well-known problem in most of the western countries. The dominant perception about computer science field considered it as a masculine domain. In contrast, this study was performed in the IT department where female students are dominant compared to male students. The purpose of this study is to explore the influence of different factors on female students in choosing a career in the IT field. A survey was deployed to collect responses of female students in the IT department. The results show that female students are interested in computer science stream and nullify the dominant perception of computer science as a masculine domain. They want to learn technology, become an active member of the digital native world, and interested in coding literacy.

Keywords—Women's perception, Career choices, Influential factors, Skills and Characteristics, computer science

1 Introduction

Females are under-represented in IT industry and computer science courses in secondary and post-secondary education in most of the western countries. Computer science is considered as masculine domain [1]. Consequently, women are excluded from many of today's most attractive career opportunities [2]. On the other side, Microsoft published a report which depicts that American colleges are not producing enough graduates in computer science to meet expected demand up to 2020 [3]. To meet the demands of the industry, it is important to motivate teenage girls toward computer science. Research indicates that most girls show a lack of interest in computer science and engineering from grade eight and earlier [2]. The career choices of teenage girls are influenced by many factors [4]. Teenage girls receive career information from many different informal (parents, friends, etc.) and formal (teachers, counselors, etc.) sources. In order to influence more girls towards IT, it is important to

provide comprehensive information which should be in accord with the girl's criteria [5].

The current study illuminates the weakness of this kind of negative critical analysis. The IT department at Buraimi University College has more female students (72%) compared to male students (28%).The World Bank report about education in Oman mentioned that the young women have 'high levels of tertiary education completion similar to levels in top-performing countries, such as Singapore and South Korea' p.23 [6].

The purpose of the current study is to explore the motives behind career choices of female students in the IT field. A survey was deployed with the female students in the IT department. The survey responses were analyzed to determine the influence of different factors on female students in choosing the IT field.

This paper is divided into a number of sections. It starts with a review of the literature, followed by research questions of this study. The methodology used for this study is then described, and research results are reported and discussed. The paper concludes with a summary of the outcomes and suggestions for future work.

2   Literature Review

Previous studies depict that in higher education there are low and shrinking numbers of female students studying computer science in Europe and the United States. 'The dominant western perception of the relationship between gender and computer science codes the latter as masculine and the low number of women are seen at least partly as an effect of that coding' p.1 [7]. Furthermore, the modern American culture stereotypes computer science as a male-oriented field that involves 'social isolation,' an intense 'focus on machinery,' and 'inborn brilliance' [8]. The American and other western countries value these qualities more in men than women. These issues can be addressed by involving teachers, media, parents and providing an inclusive culture at work [8]. Reference [9] argued that families play an important and significant role in girls' career choice. On the other side, family knowledge about the IT careers are often limited [10] and hence they rarely promote IT as a career option [4]. Media stereotypes IT workers as geeky [11] and nerdy [12] are alleged to discourage females from pursuing a career in computing significantly. Some studies reported that many teachers have limited knowledge and experience of IT, and therefore did not encourage students to consider IT as a career or help students in understanding IT work [4][13].

The social barriers for women's to enter into the computer science field are also described in the literature [8]. Some of these barriers are listed as:

- Teachers, parents, and others steered away females from the computer science field because they believe that males are best suited for this field [14].
- Females are reluctant to enter a male-dominated environment [15].
- Females are under-estimated systematically that how well they can perform in this field and this leads to their lower interest in computer science [16].

- Females are reluctant to enter in this field because they anticipate that it may conflict with their work-family interests [17].
- Qualified females may not get the same opportunities in this field as their male counterpart because it is male-dominated [18].
- Computer science is considered as a male-dominated domain so females can be professionally and socially penalized for showing their leadership and competence qualities [19].

Reference [5] conducted a study with teenage girls who participated in a New Zealand-based intervention: the Programming Challenge 4 Girls related to their career preferences. They concluded that there should be informal (parents, friends, peers) and formal (teacher/counselor, government, professional bodies and industry associations) sources of career information for the teenage girls related to the IT career. The formal sources should provide accurate and suitably presented information to teenage girls in contrast to informal sources for whom the same degree of suitability and accuracy cannot be expected. The participants rated these factors highly ('how much people interaction there was,' 'whether there was a sense of fun,' and 'whether the work environment was cool') for a desirable career. Practical issues such as 'job location,' 'hours of work' and 'travel time' were given less important by the participants.

Reference [2] deployed a survey with both boys and girls students for determining the influences of different factors on their careers. They concluded that female students indicated less interest and abilities in computing science than did the male students. Personal interest and abilities were rated as the most influential factors for choosing career direction by both female and male students. For questions related to skills and characteristic requirements for computer professionals, female students perceived 'basic computer skills,' 'fast typing,' and 'problem-solving' as the most important skills. Likewise, they rated high for 'smart,' 'knowledgeable' and 'organized' characteristics to be a successful computer professional.

Reference [7] conducted a study in Malaysia with computer science students and faculty. She mentioned Malaysia a different case because 'there are large numbers of women in computer science, and computer science is not perceived as masculine' (p.5). The participants emphasized that their motivation to study computer science was to get a well-paid and secure job. Furthermore, they said that computer science jobs are indoors which is considered as more protected, woman-friendly place, compared to spaces like factories and construction sites. The participants like software engineering, programming, and hardware areas of computer science contrast to what many westerners perceive as masculine areas.

3 Research Questions

It is evident from the previous section that low and shrinking numbers of women in computer science are a well-known problem in most of the western countries. In contrast, this study was performed in the college where there are more female students (72%) compared to male students (28%), a rare situation in IT. This study aims to

explore from the female students the different influential factors for choosing IT career by addressing the following three research questions:

RQ1: what is the influence of different social factors in choosing your computer science career?

RQ2: what skills and characteristics are required to be a successful computer professional?

RQ3: what are the most difficult and the easiest areas of study in computer science?

4 Research Methodology and Design

A survey was conducted with the female students to explore their career choices in IT. The survey consists of five parts. The first research question was investigated in the second part of the survey. The second question was probed in the third and fourth parts of the survey. Lastly, the third research question was explored in the last (fifth) part of the survey.

4.1 Preparation of the survey

The survey was prepared to explore the career choices of the female students studied in the IT department. It consists of 37 closed-ended questions. The survey has five parts.

The first part covers demographic questions related to students' major, degree, Cumulative GPA, age and passed credit hours.

The second part covered questions which are mainly related to the influence of different factors in choosing the female students major in computer science. Eleven different factors were included in this section. A five-point Likert scale was used, from not at all influential (1) to extremely influential (5). This part of the survey was based on a survey developed by reference [2] except one-factor 'sponsorship.'

The third part of the survey focused on questions related to skills required to be a successful computer professional. This section included nine different factors. Again, five-point Likert scales were used, from never (1) to always (5). All the factors mentioned in this part of the survey were taken from the survey developed by reference [2].

The fourth part covered questions related to characteristics required to be a successful computer professional. Ten different factors were included in this section. The same five-point Likert scales, used in the third part of the survey (never (1) to always (5)), were also utilized in this section. This part of the survey was also based on the survey developed by reference [2].

The last part of the survey focused on questions related to the most difficult and easiest areas of study in computer science. Six different areas of study were included in this section for both questions.

4.2 Population and Ethical Consideration

The population being surveyed consisted of female students in the IT department at Al Buraimi University College (BUC), Oman. The reason behind the selection of BUC could be attributed to the reason that BUC has become one of the growing Colleges in Oman that is keen about providing reliable technological environment to their students and educators [36] - [43]. 189 female students participated in the survey from all the three majors (Computer Science, Software Engineering and Information Systems) offered in the department. The data was collected after obtaining ethical approval from Buraimi University College, Oman. The data collected through the web-based survey from the female students was anonymous. The participation was voluntary.

5 Results

This section describes the results of this study and probes Research Questions 1, 2 and 3. The responses of the survey are analyzed as follows:

5.1 Analysis of the survey

The survey consists of following five parts:

1. Demographic information
2. Influences on career choices
3. Skills requirements for computer professionals
4. Characteristics of computer professionals
5. Area of study in computer science

5.2 Demographic information

The demographic details of the respondents as follows:

- 47.6% respondents are enrolled in Computer Science major, compared to 37.5% from Information Systems and 14.8% from Software Engineering.
- Most of the respondents (79.3%) are pursuing their studies at bachelor level as compared to 20.7% for advanced diploma and diploma.
- 46.6% respondents have CGPA range between 2.00 to 2.99, compared to 41.8% from 3.00 to 4.00 and 11.6% from 0.00 to 1.99
- The majority of the respondents (72.5%) have age between 18 to 22 years as compared to 22.3% from 23 to 28 years, 3.7% from 29 to 35 years and 1.5% above 35 years.
- 30.2% respondents have passed 61-90 credit hours, compared to 25.9% from 31-60, 23.3% from 91-126, and 20.6% from 0-30 credit hours.

5.3 Influences on career choices

In this section, we address the first research question which is:

RQ1: what is the influence of different social factors in choosing your computer science career?

The influences of different factors in choosing computer science major on the respondents are shown in table 1. The means and frequencies of the responses are included in the table.

Table 1. Influences of different factors on career choices

Factor	Mean	Extremely Influential (%/N)	Very Influential (%/N)	Somewhat Influential (%/N)	Slightly Influential (%/N)	Not at all Influential (%/N)	Total (%/N)
Parents	2.83	11.6%	22.2%	25.9%	17.5%	22.8%	100%
		22	42	49	33	43	189
Teachers & Counselors	2.58	2.6%	24.3%	29.6%	15.3%	28.0%	100%
		5	46	56	29	53	189
Friends	2.62	8.9%	19.0%	25.9%	17.4%	28.6%	100%
		17	36	49	33	54	189
Job opportunities	2.94	11.6%	19.0%	38.1%	14.3%	16.9%	100%
		22	36	72	27	32	189
Job image	2.94	10.1%	19.6%	39.7%	15.3%	15.3%	100%
		19	37	75	29	29	189
Personal interest	3.22	14.8%	32.2%	25.9%	14.3%	12.7%	100%
		28	61	49	27	24	189
Personal abilities	3.11	13.2%	23.3%	35.4%	17.4%	10.6%	100%
		25	44	67	33	20	189
Financial rewards	2.84	7.4%	18.5%	41.3%	15.9%	16.9%	100%
		14	35	78	30	32	189
Flexible hours	2.99	10.6%	19.6%	41.8%	14.3%	13.8%	100%
		20	37	79	27	26	189
Make the world a better place	3.24	13.8%	28.0%	35.9%	13.2%	8.9%	100%
		26	53	68	25	17	189
Sponsorship	2.68	5.3%	17.9%	34.4%	24.3	17.9%	100%
		10	34	65	46	34	189

The results show that respondents influence the most in choosing their career in computer science from 'Make the world a better place' (3.24), 'personal interest' (3.22), and 'personal abilities' (3.11). 'Teachers & Counselors' (2.58), 'Friends' (2.62) and 'Sponsorship' (2.68) were perceived as the least influential factors for respondents. The respondents were influenced equally by 'Job opportunities' (2.94), and 'Job image' (2.94).

5.4 Skills requirements for computer professionals

This section probes the first part of the second research question related to skills requirements for computer professionals. The second research question is as follows:

RQ2: what skills and characteristics are required to be a successful computer professional?

The third part of the survey focused on questions related to skills required to be a successful computer professional. Table 2 gives an analysis of respondents perceptions about the different skills required for computer professionals.

Table 2. Skills requirements for computer professionals

Factor	Mean	Always (%/N)	Often (%/N)	Sometimes (%/N)	Rarely (%/N)	Never (%/N)	Total (%/N)
Math	3.35	23.3%	21.2%	35.4%	7.4%	12.7%	100%
		44	40	67	14	24	189
Problem solving	3.57	31.2%	16.4%	34.9%	12.7%	4.8%	100%
		59	31	66	24	9	189
Graphics	3.37	17.5%	26.9%	35.9%	14.3%	5.3%	100%
		33	51	68	27	10	189
Basic computer skills	3.78	37.6%	19.0%	30.2%	10.0%	3.2%	100%
		71	36	57	19	6	189
Logic	3.46	23.3%	23.8%	35.9%	9.5%	7.4%	100%
		44	45	68	18	14	189
Communication	3.70	31.7%	25.4%	29.1%	8.5%	5.3%	100%
		60	48	55	16	10	189
Creativity	3.41	19.6%	25.4%	36.5%	13.2%	5.3%	100%
		37	48	69	25	10	189
Fast typing	3.49	20.6%	23.8%	43.9%	7.4%	4.2%	100%
		39	45	83	14	8	189
Business knowledge	3.07	11.6%	23.3%	35.9%	19.1%	10.1%	100%
		22	44	68	36	19	189

The respondents perceived 'Basic computer skills' (3.78), 'Communication' (3.70) and 'Problem-solving' (3.57) as the most important skills required to be a computer professional. Other skills such as 'Fast typing' (3.49), 'Logic' (3.46), 'Creativity' (3.41), 'Graphics' (3.37), 'Math' (3.35) and 'Business knowledge' (3.07) were also perceived as useful by respondents.

5.5 Characteristics of computer professionals

In this section, we address the second part of the second research question related to characteristics requirements for a computer professional. The second research question is as follows:

RQ2: what skills and characteristics are required to be a successful computer professional?

The next part of the survey covered questions related to characteristics required to be a successful computer professional as shown in Table 3.

Table 3. characteristics of computer professionals

Factor	Mean	Always (%/N)	Often (%/N)	Sometimes (%/N)	Rarely (%/N)	Never (%/N)	Total (%/N)
Smart	3.59	27.5%	24.9%	32.3%	10.1%	5.3%	100%
		52	47	61	19	10	189
Patient	3.36	19.0%	21.7%	40.2%	14.3%	4.8%	100%
		36	41	76	27	9	189
Analytical	3.36	15.9%	27.5%	40.2%	14.3%	6.9%	100%
		30	52	76	18	13	189
Knowledgeable	3.46	23.3%	22.8%	34.9%	14.8%	4.2%	100%
		44	43	66	28	8	189
Hard Working	3.51	29.1%	16.9%	36.5%	10.6%	6.9%	100%
		55	32	69	20	13	189
Good memory	3.53	23.8%	29.1%	31.2%	8.5%	7.4%	100%
		45	55	59	16	14	189
Team player	3.30	21.7%	17.4%	39.2%	12.7%	8.9%	100%
		41	33	74	24	17	189
Organized	3.42	23.3%	22.2%	33.9%	14.3%	6.3%	100%
		44	42	64	27	12	189
Outgoing	3.20	16.4%	18.5%	40.7%	16.9%	7.4%	100%
		31	35	77	32	14	189
Eager to learn	3.36	18.5%	21.7%	43.4%	10.1%	6.3%	100%
		35	41	82	19	12	189

The respondents perceived 'Smart' (3.59), 'Good memory' (3.53), and 'Hardworking' (3.51) as the most important characteristics of computer professionals. Three factors such as 'Analytical' (3.36), 'Eager to learn' (3.36) and 'Patient' (3.36) were given equal weightage by respondents. The remaining factors ('Knowledgeable' (3.46), 'Organized' (3.42), 'Team player' (3.30) and 'Outgoing' (3.20) were also perceived as useful characteristics for computer professionals by respondents.

5.6 Area of study in computer science

This section investigates the third research question which is:

RQ3: what are the most difficult and the easiest areas of study in computer science?

The last part of the survey focuses on the most difficult and the easiest areas of studies in computer science. Figure 1 shows the responses for the most difficult area

of study in computer science and figure 2 depicts the easiest area of study in computer science.

The results show that the respondents perceived 'programming' (75) as the most difficult area of study in computer science as shown in figure 1. On the other side, 'web' (58) was perceived as the easiest area of study in computer science by respondents as shown in figure 2.
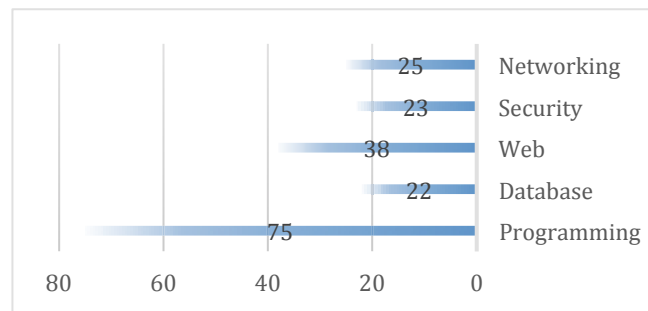

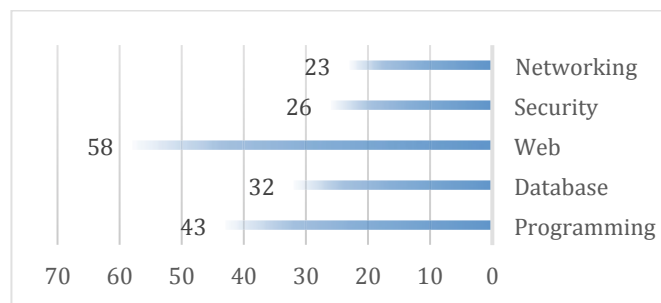**Fig. 1.** Most difficult area of study in computer science

Fig. 2. The easiest area of study in computer science

6 Discussion

The respondents perceived 'Make the world a better place' (3.24), 'personal interest' (3.22), and 'personal abilities' (3.11) the most influential factors in choosing their IT career. The results show that female students want to contribute equally with their counterparts (male students) to make this world a better place. They want to learn technology and take part in advancing the knowledge in this field. They want to prove themselves as the active member of this digital native [20] world. They are also interested in 'coding literacy' as their male counterparts. The respondents perceived that they chose IT career due to their personal interest and abilities. The finding is consistent with the reference [2]. On the other side, these findings contradict with some of the previous studies [21]-[23] which concluded that female students are less motivated and confident to study computer science. The results show that 'Teachers & Counselors' was perceived as one of the least influential factors for respondents. Ref-

erence [5] mentioned teachers and counselors as a formal source of information for teenage girls to motivate towards IT career. Therefore, it is important for the education providers to engage teachers and counselors in this process actively.

The respondents perceived 'Basic computer skills,' 'Communication,' and 'Problem-solving' as the most important skills required to be a computer professional. The basic computer skills are required to apply for an entry-level job in the IT sector. In the context of this study, English is a second language for respondents, so they perceived communication as one of the most important skills required to be a computer professional. Reference [24] discussed that students' lack of English language abilities is one of the reasons for poor understanding of computer programming concepts in the Gulf region. The third most important skills perceived by the respondents are problem-solving. Reference [25] defines problem-solving as 'a mechanism for achieving a solution to a programming problem' (p. ix). Moreover, programming knowledge (syntax and semantics) and problem-solving strategies are considered equally important skills in computer science [26], [27].

The respondents perceived 'Smart' 'Good memory' and 'Hardworking' as the most important characteristics to be required for a successful computer professional. The findings ('Smart' and 'Hardworking') are consistent with the reference [2]. 'Good memory' was rated low in the findings of reference [2]. As discussed earlier, English is a second language for respondents in our context. So they have to struggle more to understand and reproduce the computer concepts and hence perceived 'Good memory' as the most important characteristics of computer professionals.

Programming was perceived as the most difficult area of study in computer science by the respondents. Previous studies [28] [29] also reported high failure and dropout rates in the programming courses. One of the reasons is traditional approaches used in the teaching of introductory programming courses emphasize more on syntax and semantics of the programming language rather than problem-solving strategies to address programming problems [30][44][45]. These traditional approaches promote programming shortcut [31] where a problem statement is directly converted into a computer program.

Problem Statement → Codes

Reference [32] introduced a teaching and learning approach in the programming course based on an ADRI (Approach, Deployment, Result, Improvement) model which discourages programming shortcut. The ADRI editor [33] was prepared based on the four stages of the ADRI model which encourages students to follow the following programming process:

Problem Statement → Problem Solving Strategies → Codes

Reference [46] offered the introductory programming course for students with the additional support of accessing the teaching materials on mobile devices. The results show that mobile devices supported learning helped students in accessing the lectures and understanding the programming concepts. This approach is consistent with refer-

ence [47] who advocated that information communication technology (ICT) promotes the teaching and learning process.

The respondent's perceived web as the easiest area of study in computer science. If the introductory programming course is offered with web-based programming languages, it will help computer science and related departments in retaining students. Reference [34] designed an introductory programming course featuring HTML, JavaScript, and Java. Students started programming with HTML and JavaScript; programs are run in web browsers, where students don't have to worry about the compilation overhead. The result shows that students passed the course with a high average mark. References [35] also integrated web services in the introductory programming course for female students.

7   Limitation

The limitation discussed below for this study provides a critical analysis of the contributions the findings make to the field of computer science. The focus of this research project was limited only to the population of one specific location. Findings of this study may not be generalizable to populations of other cultures and locations. However, in spite of this limitation, by following sound practices in the research, the findings and conclusions may serve to inform the field of computer science.

8   Conclusion

The low and shrinking numbers of female students were reported in Europe and the United States in higher education in computer science. This study was conducted in the college where there are more female students (72%) compared to male students (28%). The purpose of this study was to explore the career choices of female students belonged to the IT department. A survey was conducted with the female students, and the survey contains 37 questions.

The result shows that the respondents perceived 'Make the world a better place,' 'personal interest,' and 'personal abilities' the most influential factors in choosing their IT career. 'Teachers & Counselors' was perceived as one of the least influential factors for respondents. The education providers should engage teachers and counselors actively in this process to motivate teenage girls in the IT field. Interestingly, 'Job opportunities' was rated low compared to the 'personal interest' by the respondents.

The respondents perceived 'Basic computer skills,' 'Communication,' and 'Problem-solving' as the most important skills required to be a computer professional. English is a second language for respondents, so they consider it as an extra challenge in studying computer science. Problem-solving strategies such as pseudo-code and flowchart should be incorporated in the syllabi from the first semester of the computer science program.

'Smart,' 'Good memory,' and 'Hardworking' were perceived as the most important characteristics for computer professionals by respondents. As mentioned earlier, English is a second language for respondents. Therefore, they have to struggle more to

understand and reproduce the computer concepts and hence perceived 'Good memory' as the most important characteristics of computer professionals.

'Programming' was perceived as the most difficult area of study in computer science by the respondents. On the other side, the respondents perceived 'web' as the easiest area of study in computer science. If the introductory programming course is offered with web-based programming languages, it will help computer science and related departments in retaining students.

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