

AC 2007-751: GENDER GAP IN COMPUTER SCIENCE: STUDYING ITS ABSENCE IN ONE FORMER SOVIET REPUBLIC

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Gender Gap in Computer Science: Studying Its Absence in One Former Soviet Republic

Introduction

It is no secret that women in the United States avoid Computer Science (CS) as a career choice. This is a big problem not only in the USA, but in numerous other countries around the world. However, there are countries – such as some of the republics of the former Soviet Union – where this problem never existed. For example, in the Computer Science department of Yerevan State University, Republic of Armenia, throughout all of the 1980s and 90s the percentage of women never fell below 75% (until mid 1990s this was the only CS program in Armenia and contained around 1,200 majors). The situation was similar in most of the soviet republics. The soviet society, culture, and educational system in many ways are quite different from the USA's and therefore may contain factors that positively affect women and attract them to CS. This motivated us to start an international investigation (in 2005) involving former soviet countries and the USA on the issue of women's interest and participation in CS; our goal is (i) to identify factors that attract women to CS in former soviet countries and find out whether or not these factors work in the USA, and (ii) to find out whether or not some of the well known negative factors that affect women in the USA¹⁻⁵ exist in those countries. We believe that such information will bring a better understanding of the problem in the USA and will contribute to designing more effective solution strategies.

In 2005-06, with the support of the Engineering Information Foundation, we carried out a study involving one former soviet country and the USA; we conducted a series of surveys and interviews in the Republic of Armenia, one of the major CS centers of the former Soviet Union, followed by matching surveys in the USA. In this paper we present some of the data, observations, and findings of the study; additional results of the first (Armenian) phase of the study can be found in a separate paper⁶.

The investigation is ongoing (we plan to research more than one former soviet republic), and therefore it is early to make final conclusions; however, the results obtained so far are significant enough to be presented at this time.

Armenia, the Target Country

Note: All facts and statements in this section are taken from reliable official web sites⁷⁻¹⁰.

Armenia (short for Republic of Armenia) is one of the 15 republics of the former Soviet Union (USSR). It covers an area of 29,800 square kilometers (slightly smaller than Maryland) and is located in the Southern Caucasus between the Black and Caspian Seas. It shares borders with Turkey to the west, Georgia to the north, Azerbaijan to the east, and Iran to the south. Armenia is one of the oldest and most historic civilizations in the world with a rich cultural heritage; its history goes back to the 2nd millennium BC. Armenia was the first country in the world to adopt Christianity as its official state religion (in 301 AD).

As of July 2006, Armenia has a population of 3.2 million (with almost equal sex ratio), 64.1% of which is urban. The capital city is Yerevan with 1.3 million population. According to the 2001 census, ethnic Armenians make up 97.9% of the population; the remaining 2.1% of the population consists of Russians, Ukrainians, Georgians, Greeks, Assyrians, and Yazidi Kurds.

Armenians have their own highly distinctive alphabet and language. The alphabet was invented in the 5-th century and consists of 36 letters. The literacy rate in the country has been 100% since 1960. 96% of the population in the country speaks Armenian; 75.8% of the population additionally speaks Russian (as a result of the soviet language policy). These days English is increasing in popularity (for many decades it is being taught in high schools as a 3-rd language).

Armenia has a 1,500 year old education history. The existing educational system was established in the soviet era many decades ago and has enabled Armenia to expand engineering and machine-tool industries, electronics and radio electronics, power engineering and nuclear energy, biotechnology, astrophysics, chemical and light industries.

Outline of the Study and Demographics

The study was carried out in Armenia and in the USA in the form of anonymous surveys and interviews; the participation was strictly on voluntary basis. We surveyed 466 students in Armenia and 453 students in the USA; all student surveys were conducted in classrooms during regular class time with the permission of the instructor and the consent of all participants. Additionally, in Armenia we surveyed 72 professionals in different fields and interviewed 85 people of certain pre-defined categories to obtain more information and explanations on some facts, trends, and tendencies in that country.

Surveys

We developed three 23-question surveys for different population groups: two student surveys for CS majors and non-CS majors respectively, and a third survey for university graduated professionals working in different fields. All three surveys shared a subset of questions, which allowed us to (i) determine the public opinion about certain matters, and (ii) detect the differences in viewpoints of different population groups on the same subject. About $\frac{3}{4}$ of each survey consisted of 5-point Likert-scale questions (some of these questions also provided additional space for comments or explanations), and the rest were open-ended questions and multiple-choice questions containing the “other” choice.

In Armenia the student surveys were carried out at Yerevan State University (YSU), the oldest university in the country (founded in 1919). The choice of YSU as the site of research was based on the following facts:

1. YSU is one of the two largest universities in the country by the number of students (the other one is the State Engineering University of Armenia).
2. YSU is by far the most “versatile” university in Armenia with the largest number and variety of fields that students can major in; it has 18 departments covering fields from Math and Sciences to History and Business, each of which has several programs (called “chairs”).

3. The CS program at YSU is the oldest CS program in the country; until mid 1990s it was the only CS program in Armenia.
4. The CS program at YSU is the largest CS program in the country with 867 majors in graduate and undergraduate programs together (currently there are 29 institutions on IT education in Armenia, 6 are state owned and 23 are private).

In Armenia we surveyed 538 individuals total: 466 students (240 males and 226 females) in different years of study, including 254 CS majors and 212 non-CS students majoring in different fields, as well as 72 university graduate professionals in different fields.

In the USA student surveys were conducted at California Polytechnic State University and Cuesta College, both in San Luis Obispo; these institutions are compatible with the YSU in their size and versatility of fields. We surveyed 453 students (266 males and 187 females) in different years of study, including 227 CS majors and 226 non-CS students majoring in different fields.

Interviews:

In Armenia we conducted 85 structured personal interviews with strategically chosen target populations. We interviewed:

- 7 academic administrators from different universities: to clarify the trends and tendencies behind enrollment numbers
- 14 CS professors from different universities: to get their views and opinions on the “kind” of young people, especially women, who choose to be in the CS field, and the motivations behind that choice
- 12 non-CS professors from different universities: to get their perspective on how students choose their major
- 5 owners of CS related businesses: to learn about their criteria and preferences when hiring new people, and their opinions on the differences in the performance (if any) of their male and female employees
- 47 parents of university applicants: to get the stories of how their children came to the decision about their major, and what were the main factors behind their choice (in soviet educational system students are required to choose a major when applying to a university). The interviewees were chosen/approached randomly in the crowds of parents cheering for their children during the university entry exams in August, 2005.

Computer Science in Armenia

Through our interviews we found out that CS is one of the most popular majors for young people in today’s Armenia; it is considered to be a highly reputable field that provides well paid jobs and guarantees a financially secure and comfortable future. Our survey showed that when applying to the university, the 37% of non-CS majors (31% of women and 48% of men) have considered choosing CS as a major.

As mentioned in the Introduction, throughout the 1980s and 90s the percentage of female population in the Computer Science department at YSU never fell below 75%. Although today women are still well represented in CS programs in Armenia, their participation is not as high as

it has been in the past: the percentage of women in different CS programs is within the range of 45-60%. Through interviews with academic administrators from different universities, we came to understand the reasoning behind this decline: apparently, it is not a result of lower interest of women with this field, as one may think, but it is due to the growing popularity of CS among men. We learned that in the past the job market for CS graduates mostly consisted of scientific-research institutions – as one of the major CS centers in the USSR, Armenia had a large number of such institutions. During the last few years, however, due to the prospering of privately owned local and foreign computer related businesses, CS became a very desirable field and started to attract a larger number of young men than in the past, thus creating a stiffer competition for women attempting to get into this major.

Interestingly, the decrease of the female population in CS programs gave a boost to the number of women entering the Math programs (close to 20% increase has been recorded for the last 5 years). Our interviews revealed the predominant cause of this trend: apparently, women who can't get into CS programs pick the closest related field, which in Armenia is considered to be Math, with the intention to take additional Computer Science courses and join the CS workforce after graduation.

One of the factors attracting young people (both men and women) to CS is the wide range of employment opportunities. In addition to the large number of scientific-research institutions, there are many CS related businesses and companies in Armenia that are looking to hire devoted, hard working, energetic, and smart professionals. Our interviews with some of these company owners exposed one interesting trend: apparently, many employers are inclined to hire women, although they don't consider men to be any less talented. The reason, they explained, is that women are loyal, dedicated, and less ambitious – usually women are satisfied with their work and they don't tend to change jobs frequently. The story is different with men, we were told – once men get trained and become accomplished at what they do, they start looking for a higher paying job or better opportunities.

Thus, we observe that in Armenia women are highly interested in the CS field; it seems that they have no difficulty in finding reputable and well paid jobs in computer related fields, which is a major motivation for choosing a career in CS (we'll discuss this in later sections).

Women in Computer Science: Armenia vs. USA

Armenia has a well represented female population in CS while the United States is having a hard time recruiting women into this field. Are attitudes and cultural biases in Armenia more favorable for CS? Our investigation gave some very unexpected and interesting results.

One of the goals of our study was to examine the attitudes and opinions of young people on women in CS; our intention was to detect any factors that could be influential on women's desire to be in this field. Results of the study came out very different in the two countries. To give an idea about these differences, below we present the charts of percentage frequencies for three 5-point Likert-scale survey questions in both countries (for clarity, all numerical values are rounded to the nearest integer).

Question 1: Is CS a suitable field for women?

The most unpredicted results of our study are related to this question. Percentage frequencies in Armenia (see Figure 1) indicate that in this country CS is not collectively embraced as a female-suitable field: positive answers were given only by 77% of women and 43% of men in the CS major, and 82% of women and 58% of men in the non-CS majors. These results demonstrate two tendencies that are consistent throughout other related questions of the survey:

- In Armenia women are significantly more positive in their answers than men
- In Armenia non-CS majors are more positive in their answers than CS majors

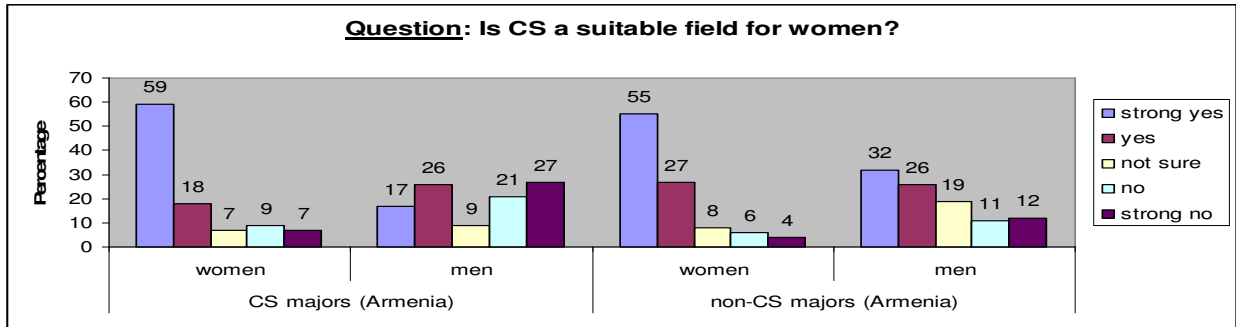


Figure 1: Percentage frequencies for Question 1 in Armenia

The Armenian results are quite unexpected and especially surprising when compared to the data from the USA. In Figure 2 we present percentage frequencies for the same question in the USA.

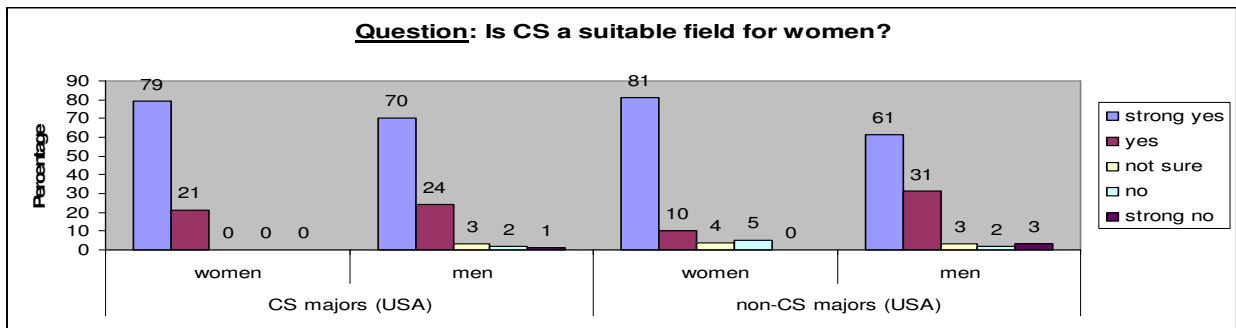


Figure 2: Percentage frequencies for Question 1 in the USA

Considering the high female presence in the CS field in Armenia, the results of this and other related questions in the survey lead to an observation that male negativity is not a significant factor in Armenia, as long as women believe that CS is a suitable field for them. As one of the Armenian female CS professors put it, “The undermining of women’s abilities is a remainder of the “stone age” mentality which is not practiced really, but only expressed in opinions”.

Question 2: In the CS field can women achieve the same successes as men?

The charts in Figures 3 and 4 present the percentage frequencies for this question in Armenia and in the USA respectively. As seen in Figure 3, in regards to Question 2 in Armenia positive

answers came from 80% of women and 58% of men in the CS major, and from 90% of women and 60% of men in the non-CS majors. On the other hand, as seen in Figure 4, in the USA positive answers came from 82% of women and 80% of men in the CS major, and from 62% of women and 70% of men in the non-CS majors.

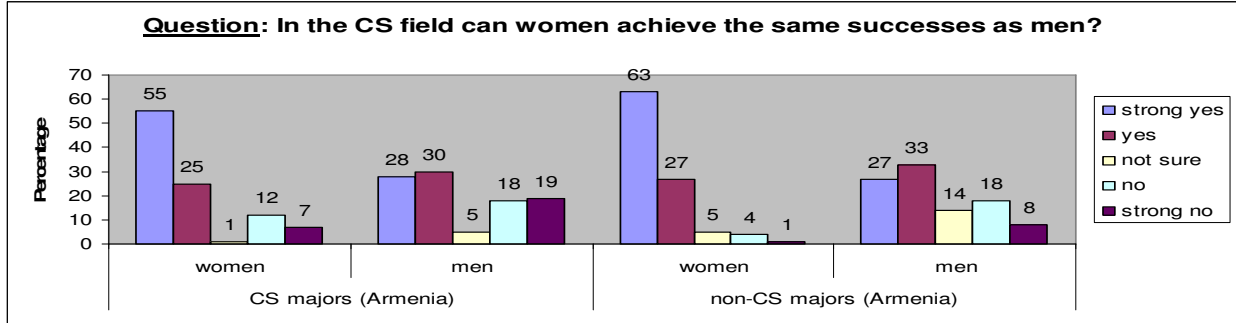


Figure 3: Percentage frequencies for Question 2 in Armenia

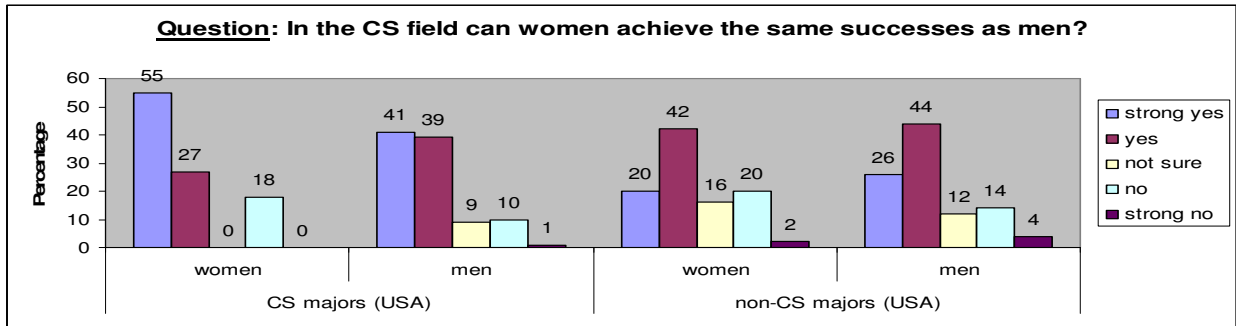


Figure 4: Percentage frequencies for Question 2 in the USA

These results illustrate the same two tendencies pointed out for Question 1, namely:

- In Armenia women are significantly more positive in their answers than men
- In Armenia non-CS majors are more positive in their answers than CS majors

Additionally, we detect the following two tendencies demonstrated also by the results of other related questions of the survey:

- In the USA non-CS majors are significantly less positive in their answers than CS majors
- Non-CS major women in the USA are by far less positive in their answers than in Armenia

These results lead to an observation that in America women outside of CS may have a perception of low female success in this field, which may very well be a reason for avoiding it as a career.

Question 3: *In the CS field are women less regarded than men?*

The charts in Figures 5 and 6 present the percentage frequencies for this question in Armenia and in the USA respectively. These results show that in both countries a significant portion of surveyed students believe that women are less regarded in the CS field than men. In Armenia such opinion is shared by 54% of women and 50% of men in the CS major, and 24% of women

and 31% of men in the non-CS majors. In the USA the respective numbers are 51% of women and 38% of men in the CS major, and 55% of women and 41% of men in the non-CS majors.

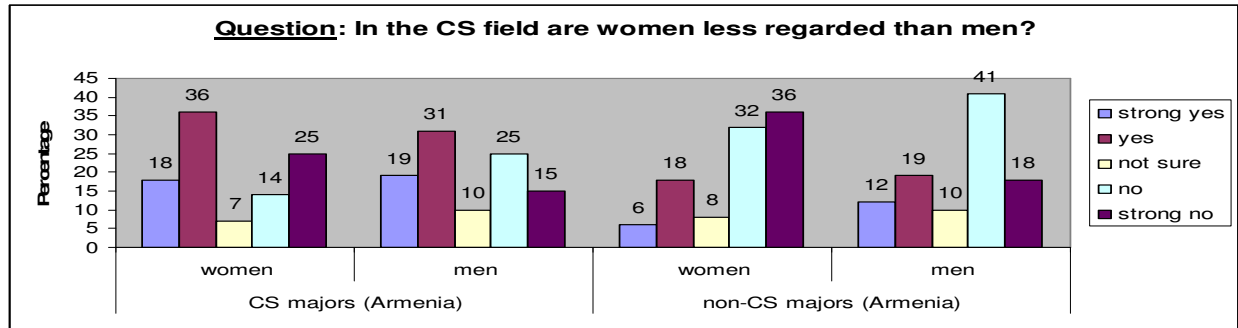


Figure 5: Percentage frequencies for Question 3 in Armenia

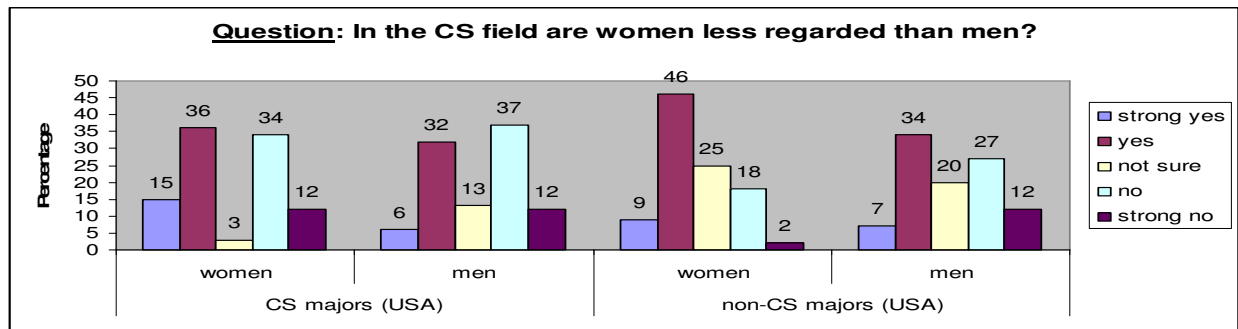


Figure 6: Percentage frequencies for Question 3 in the USA

These results demonstrate familiar tendencies (seen in one or both previous questions), namely:

- In Armenia non-CS majors are significantly more positive in their answers than CS majors, and among them women are more positive than men
- In the USA non-CS majors are less positive in their answers than CS majors
- Non-CS major women in the USA are by far less positive in their answers than in Armenia

Female Retention Rate in CS Programs in Armenia

It is well known that in the USA the female retention rate in CS programs is not very high; a considerable number of women change their mind about having a career in CS soon after entering the program. When setting up the study, we were curious about the female retention rate in CS programs in Armenia. That information is even more interesting now, in the light of above presented data.

Through interviews with university administrators, we established that in Armenia changing one's major is an extremely rare act; apparently, in the soviet educational system the procedure of changing a major is so complicated that it is hardly ever practiced. Therefore, there is no official data reflecting student satisfaction with their major. Nevertheless, our survey results shed some light on this matter in Armenia; Figure 7 summarizes the answers of CS majors to the

question “Do you feel you have chosen the right major?” (it is important to mention that the demographics consisted of almost equal number of CS majors in each year of study).

As seen in these results, in Armenia the overwhelming majority of CS students (83% of women and 95% of men) believe they have chosen the right major. The small percentage and low intensity of negative answers lead us to believe that if the major change was an easy option for Armenian students, the female retention rate in CS programs would still be very high.

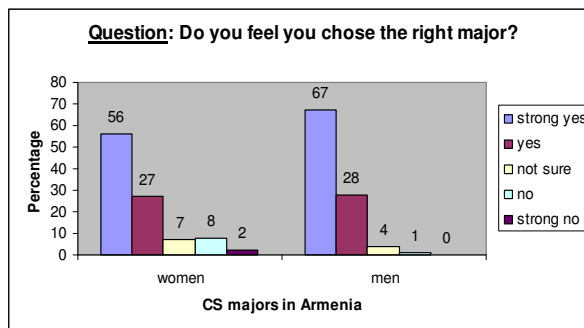


Figure 7: Percentage frequencies

Few Remarks

The above presented questions are only a small portion of the questionnaires, but they give an idea about the type of results we got in the two countries. As mentioned earlier (page 2), in addition to the two student surveys, in Armenia we also conducted a third survey among university graduated professionals in different fields; the results are almost identical to the student survey results, therefore in this paper we won't discuss them separately.

The analysis of the data of the whole study leads us to believe that:

1. In Armenia a considerable portion of men have a negative perception on women in CS, however that doesn't stop women from choosing CS – we observe that women are still greatly interested in this field since THEY find it suitable and appealing.
2. In Armenia women outside of the CS field have a very positive perception on the success and opportunities females can have in CS – this, we believe, plays a major role in the popularity of this field among women.
3. In the USA, on the other hand, despite the overwhelmingly positive opinion about the female-suitability of the CS field, a significant percentage of young women (especially outside of CS major) have a negative perception on women's possibilities and treatment in the CS field – this result is consistent with the findings of other researchers¹⁻⁵ and, we believe, is a major factor for American women to avoid a career in CS.

Choosing CS as a Major: Armenia vs. USA

Through our surveys of university students and interviews with predefined target populations (university administrators, professors, parents), we were able to detect a few specifics in the former soviet society and educational system, as well as in Armenian national mentality, that in our opinion contribute to the popularity of the CS field among women.

Without getting into a debate about the good or the bad in the former soviet system in general, we want to bring to the reader's attention few specifics in this society that we believe are relevant. First, it is important to remember that the education in the former soviet system was free at every level. The higher education was available to everyone – the only criterion was a student's knowledge/abilities/talents, which was determined by acceptance examinations.

Another important aspect of the former soviet system was that people in different fields were paid approximately the same salary, and therefore there were no financial incentives for choosing one field over the other. However, there were financial, as well as reputation and power related incentives for advancing in a field. Through our interviews we came to understand that back in soviet days young people were motivated and able to choose a field that would allow them to excel and reach the highest of their potential.

After the fall of the soviet regime Armenia embraced a free market capitalist economy. However, the educational system has not changed significantly since the soviet times, the main change being the addition of private schools and the creation of additional private sections in public schools where students need to pay for their education. Thus, the talented and capable students in Armenia can still get a free education in a field where they can excel; however, the salaries and the level of financial advancements significantly vary in different fields – this makes some majors more desirable than others.

Our investigation in Armenia allowed us to detect a few specifics in the national mentality that we believe are fundamental for the popularity of CS among women. One of the observations was that Armenians consider themselves to be very realistic and reasonable in all aspects of their lives, including the planning of their future. When choosing a major, young people (both men and women) are persuaded by their parents and teachers to take a realistic look at their abilities and their chances in succeeding in the considered field. Following an “empty dream” (i.e. a dream that doesn’t have good odds of coming true) is not encouraged. Young people choose a major not necessarily because they like it, but more often because they believe they will be good at it and will have a successful career. There is no cultural emphasis on having a job that one loves (every one of the interviewees emphasized that the source of happiness for Armenians undoubtedly is their family and friendships, rather than their work); a job is considered by many to be merely a means to provide the financial basis for an individual to enjoy life with family and friends. Thus, there is a determination to have a profession that will guarantee a good living and financial stability. Besides, there is a perception that “when you are good at what you do, you usually end up loving what you do”. We believe that this attitude, combined with the fact that in this country CS is a highly regarded field that provides financial security, lead to the reality that in Armenia young people (both men and women) who are good in Math are entering the CS field without reservations.

This observation is consistent with the results of our survey questions on choosing a major. As an example, in Figure 8 we show the percentage frequencies for the following multiple-choice question to CS majors: “What was the decisive factor in choosing CS as a major?”. Note that this question contained more choices than shown: to make the chart less crowded, we grouped some of the low-frequency choices together with the “other” option.

The chart in Figure 8 shows that when it comes to choosing CS as a major, American students have a significantly different attitude and motivations than Armenians – being fond of the field is a decisive factor for most Americans. It is worth mentioning that the answers of non-CS majors (on the decisive factor in the choice of their major) in both countries are consistent with the results seen in Figure 8.

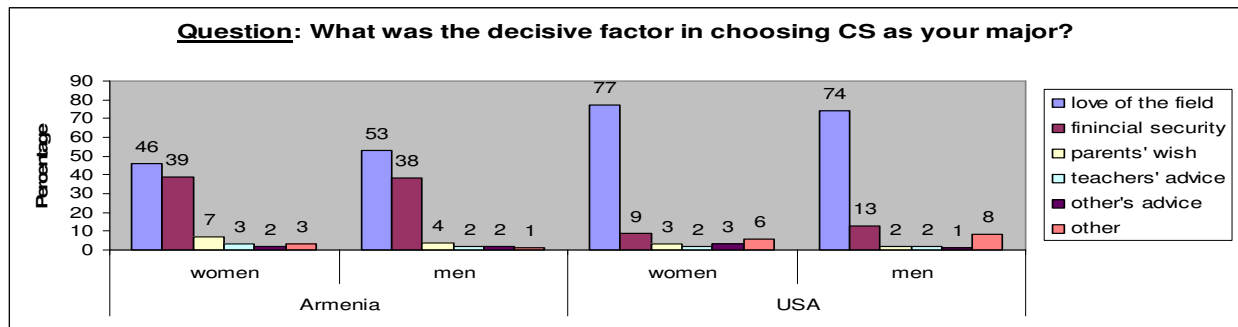


Figure 8: Percentage frequencies for “What was the decisive factor in choosing CS as your major?” question

Our survey shows that the majority of Americans (particularly women) tend to choose a major because they love the field; this is consistent with our initial opinion that American society embraces the “must love your job” attitude. In America we often encourage young people with “you should follow your dream” or “if you put your mind to it, you can achieve anything you want” – but is this always the right advice? If the young adult does not have adequate abilities or talents to achieve his/her dream career, isn’t it better to advise them to consider another field of study before too much time and energy is wasted? It is hard to say how open American parents and career counselors are in redirecting a child’s career aspirations to a different, better fitting field for his/her abilities and talents – we intend to research this matter separately – but we believe that such an intervention and more robust high school career counseling program would be very beneficial for our children and for STEM fields altogether.

Conclusion

This paper introduces some results of a study on women in CS in two countries: Armenia and the USA. These results indicate that in Armenia CS is not collectively favored as a female-suitable field. Additionally, in both countries a considerable percentage of people share the perception that women in CS are not as regarded as men, and can’t achieve the same successes as men. The negativity in Armenia comes mostly from men, while the majority of women, especially those outside of the CS field, have a very positive view on this matter. In the USA, on the other hand, the negativity is more typical to women, especially those outside of the CS field. We believe that this difference in women’s perceptions explains the uneven female presence in CS programs in the two countries.

This study is the first stage of a larger investigation involving former soviet countries and the USA, therefore we will withhold from making final conclusions or recommendations. However, the preliminary results lead to an observation that when choosing a major, young people in Armenia have different motivations and criteria than in the USA; we believe that these differences may also be credited for the popularity of CS among women in Armenia.

Acknowledgements

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