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FACTORS INFLUENCING WOMEN'S DECISION TO STUDY COMPUTER SCIENCE: IS IT CONTEXT DEPENDENT?

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ABSTRACT

Aim/Purpose	Our research goal was to examine the factors that motivate women to enroll in Computer Science (CS) courses in order to better understand the small number of women in the field of CS.
Background	This work is in line with the growing interest in better understanding the problem of the underrepresentation of women in the field of CS.
Methodology	We focused on a college that differs in its high numbers of female CS students. The student population there consists mostly of religious Jews; some of them are Haredi, who, because of their unique lifestyle, are expected to be the breadwinners in their family. Following group interviews with 18 students, a questionnaire was administered to all the female students and 449 of them responded. We analyzed it statistically. We compared the responses of the Haredi and non-Haredi students.
Contribution	The main contribution of this work lies in the idea that studying the factors underlying women's presence in a CS program in unique communities and cultures, where women are equally represented in the field, might shed light on the nature of this phenomenon, especially whether it is universal or confined to the surrounding culture.
Findings	There were significant differences between the Haredi and non-Haredi women regarding the importance they attributed to different factors. Haredi women resemble, regarding some social and economic variables, women in developing countries, but differ in others. The non-Haredi women are more akin to Western women, yet they did not completely overlap. Both groups value their family and career as the most important factors in their lives. These factors unify

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	women in the West and in developing countries, though with different outcomes. In the West, it deters women from studying CS, whereas in Israel and in Malaysia, other factors can overcome this barrier. Both groups attributed low importance to the masculine image of CS, found important in the West. Hence, our findings support the hypothesis that women's participation in the field of CS is culturally dependent.
Recommendations for Practitioners	It is important to learn about the culture within which women operate in order to attract more women to CS.
Recommendations for Researchers	Future work is required to examine other loci where women are underrepresented in CS, as well as how the insights obtained in this study can be utilized to decrease women's underrepresentation in other loci.
Impact on Society	Women's underrepresentation in CS is an important topic for both economic and social justice reasons. It raises questions regarding fairness and equality. In the CS field the gender pay gaps are smaller than in other professional areas. Thus, resolving the underrepresentation of women in CS will serve as a means to decrease the social gender gap in other areas.
Keywords	women, underrepresentation, computer science, culture, Haredi

INTRODUCTION

Despite the current growing popularity of Computer Science (CS) in higher education, women remain underrepresented in this field. In the literature, the underrepresentation of women majoring in CS and working in CS jobs is attributed to a variety of factors, such as stereotypes and beliefs about CS, a lack of female role models in CS, values and interests, computing self-efficacy, and experience in k-12 schools (Beyer, 2014; Leiman, Sax, & Zimmerman, 2017).

This literature is largely based on empirical evidence from Western countries. However, there are specific countries and academic centers where the number of female students often equals or even exceeds the number of male students (e.g., Mauritius (Adams, Bauer, & Baichoo, 2003) and Malaysia (Lagesen, 2008); see also the review by Michell, Szorenyi, Falkner and Szabo (2017) of other such countries). Those reports support the hypothesis that underrepresentation of women in CS, although widespread, is confined to the cultural context within which these women live.

Adams et al. (2003) suggested that in order to understand the underrepresentation of women in CS we should study and identify the cultural factors that differ from those in the Western world, and that underlie women's attraction to CS in those countries. Inspired by Adams, in this work we investigated an additional academic institution, the Jerusalem College of Technology (JCT), where more than 50% of its CS students are women (Levi, 2017).

The student population at JCT is mostly religious, stemming from diverse sub-groups and trends. A large part of the female population at JCT is Haredi women, who, owing to their unique lifestyle, are expected to be the breadwinners of their family (Ben-David Kolikant & Genut, 2017).

We sought to better understand what factors motivated these women to enroll in CS studies. The rationale was that eliciting these factors, compared to factors reported in the literature, regarding women in CS, might shed light on the nature of women's underrepresentation in CS, especially regarding the role that culture plays.

LITERATURE REVIEW

WOMEN'S REPRESENTATION IN CS PROGRAMS

In the US, female students make up less than 20% of all BSCS (Bachelor's degree in CS) students (Leiman et al., 2017). This picture is similar in Anglo-Saxon, Scandinavian, and German-speaking

(ASG) countries (Michell et al., 2017), as well as in Israel, where this study was conducted (Levi, 2017). There are, however, a few countries where the number of female students in CS often exceeds the number of male students, such as Malaysia (Lagesen, 2008), Mauritius (Adams et al., 2003), and Taiwan (Dee, Petrie, Boyle, & Pau, 2009). In Kenya and in some former Soviet republics, similar numbers of females and males are attracted to CS (Michell et al., 2017).

Several studies were conducted in order to better understand women's underrepresentation in CS programs, especially regarding factors that deter or contribute to women studying CS. In most of these studies, women were asked about their considerations and experiences with regard to CS studies. We will review these factors, presenting first the insights gained in studies conducted in Western countries and then in those unique places where CS female student numbers are equal to or exceed those of male CS students.

Western Countries

One factor that influences students' decisions to study CS in higher education institutions is their former experience in CS. Many girls lose interest in computer fields before beginning college. Carter (2006) surveyed high-school students and found that a prominent reason to choose (or not) to major in CS is related to their previous experience in the field. Carter found that high-school students (both males and females) severely lack experience in computing, particularly formal classroom experience. The vast majority of students had no idea what a CS major entails. For female students, such experience in K-12 school settings is a crucial factor for choosing CS (Beyer, 2014). Similarly, Dee, Petrie, Boyle, and Pau (2009) found that a compulsory computing course at school has a positive effect. Accordingly, efforts have been made to expose students to various computing fields. However, in spite of those efforts, very few of these women continue their studies and graduate with a CS degree (Dee et al., 2009).

Carter (2006) indicated another top reason for women not choosing CS studies, which is the lack of desire to sit in front of a computer all day. The difference between the responses of men and women in this respect was significant. Accordingly, the desire for a more people-oriented major was very common in women's responses. Hence, Carter suggests that interdisciplinary programs that combine aspects of CS with fields that are applied and people-oriented might be more successful in attracting greater numbers of women.

Finally, female students who had female computer teachers in high school were more likely to major in CS than were female students without female computer teachers in high school (Beyer & Haller, 2006). Asgari, Dasgupta, and Stout (2012) believe that these teachers serve as role models for the female students.

Beyer, Rynes, Perrault, Hay, and Haller (2003) inquired about undergraduate students regarding variables that could potentially adversely affect the number of women in CS. They found that students perceive the field as a masculine domain (similar results were reported by others, see, for example, Falkner, Szabo, Michell, Szorenyi, & Thyer, 2015; Leiman et al., 2017; Singh, Allen, Scheckler, & Darlington, 2007; Camp, 1997).

Computer scientists are viewed as single minded, lacking outside interests, and deficient in interpersonal skills. In fact, they are commonly viewed as nerds, geeks, or hackers. According to Siek et al. (2006), women are affected by the negative stereotypes of CS scientists and the CS domain more than men are. However, a different result was obtained by Beyer (2014), who investigated 1319 American first-year college students (872 female and 447 male) regarding gender differences in students' experience in their first CS course, which might affect their intention to take CS courses. Beyer found that women do not necessarily harbor harsh negative stereotypes about CS.

Nonetheless, women had low self-efficacy regarding their computer skills (see also the similar results of Wilson (2002)). Another factor that influences women's enrolment in CS programs is the opinions

of those close to them (see also Siek et al., 2006; Yasuhara, 2008). Finally, despite the lack of negative stereotypes about CS, women were less interested in CS because they perceived a conflict with their values and interests. CS is perceived as lacking interpersonal values (see also Eccles, Barber and Jozefowicz (1999)) and as a hard domain when one wants to combine family and career, and therefore, it does not fit women's desire to have a 'balanced' life with multiple goals. Similarly, according to Carter (2006), CS was considered as a field where family life and career are incompatible for women. The female role model was found not to have the expected effect of increasing computer self-efficacy if the female role models themselves exemplify geek stereotypes. Similar results indicating that female role models are not crucial were reported by Dee et al. (2009).

Finally, Dee et al. (2009), who studied the positive events and situations that have influenced graduate female students' career choice, found that comparing the results from mixed schools to those from single-sex (girls) schools indicated an absence of the benefit of single-sex schooling. This finding contradicts the previous often-heard effect (Jones & Clarke, 1995; Parker & Rennie, 2002).

Unique Academic Centers where Female Students in CS are not Underrepresented

Mauritius (a developing country in the Indian Ocean). Adams et al. (2003) presented information about the representation of women in CS and computer-related programs at the University of Mauritius. The findings reflect a rapid growth in the number of women in CS studies since 1994. They emphasized that Mauritius University matches incoming students with the CS program solely on the basis of ability and interest. Moreover, no special program maintains gender equity and no special efforts were made to attract more women to CS, which might explain the dramatic increase in the number of women admitted to CS studies. Instead, it appears that increasingly more Mauritians women are *choosing* to study computing, in fact approaching the proportion of women in the general population. Hence, it is reasonable to assume that CS is not perceived as a masculine domain in Mauritius. Adams et al. proposed that some cultural characteristics, which differ from those of the US and other ASG countries, make computing attractive to Mauritius women. They suggested that the financial reward attracts women, perhaps because of their life within a macro context of a developing country. Furthermore, parents or family in a developing country might encourage or even pressure the girls (and boys) to pursue a career in CS because of the associated prestige or because it is considered well-paying work.

An additional significant difference is that female and male students are educated separately at the secondary level. Adams et al. (2003) suggested that this separation could encourage women to discover their strengths. Moreover, the authors reported a decline in the percentages of female CS instructors during the same time that the representation of women in computing has been increasing, which might contradict the hypothesis that women require female academic role models in order to be attracted to CS.

Malaysia. Lagesen (2008) suggests two particular aspects of Malaysian society that might explain the trend of a high proportion of female CS students: (a) the rapid economic growth in Malaysia, and (b) the authorities' strong encouragement of young people to study technical fields. These suggestions are based on interviews conducted with female CS students at a university in Malaysia, where 52% of the bachelor's students are women. This ratio represents the gender pattern in CS education for all of Malaysia.

The interviews focused on interviewees' descriptions of their decision to study CS, in line with the tenets of micro-sociological approaches. Most of the interviewees did not consider their choice of CS as special and as something that women in general would not consider. Rather, they saw their choice as consistent with being women. All of them emphasized that their motivation to study CS was linked to their goal of getting a well-paying job. Like in Mauritius, family pressure was also a factor. For many of them, CS education offered many new and interesting opportunities to become

skilled, valued, and important. Software engineering and programming were considered as 'theoretical' and thus suitable for woman, and as providing secure work, since it is associated with office work, commonly recognized as women-friendly, more safe and protected. Although many of them lacked previous experience or knowledge of computing when they entered the program, very few complained about this.

The notion of CS as masculine was absent in both studies.

The JCT: An Additional Unique Academic Center?

As mentioned above, our study focuses on CS female students at the Jerusalem College of Technology (JCT), which is exceptional in their high proportion of CS female students (53% of the entire CS students in 2017). The JCT is also characterized by the diversity of its population. Specifically, most of the students are religious Jews and some of them belong to the Haredi community.

The non-Haredi students resemble Western women in their previous education and in other social variables. Generally, they are integrated into Israeli society; for example, they enter military service (or national service instead), as most of the Israeli women do.

The Haredi population, owing to their traditional beliefs and behavior, keep themselves isolated from the general society, a phenomenon that has both social and economic outcomes. The Haredi students are definitely different in their previous education. In fact, in 2013 only 2% of boys and 17% of girls from the Haredi community earned matriculation certificates, whereas within general Israeli society the number exceeded 50% (Malach, Choshen, & Cahaner, 2016). The Haredi society is gender differentiated. A prominent expression of the gender differentiation is that the ideal for men is to devote their life to religious studies, and for women it is to be the main providers in their household. In fact, the majority of the Haredi men do not work. Instead, many of them devote most of their time to study religious literature (e.g., the Torah); hence, the woman's responsibility, as the breadwinner, is a common phenomenon in this community. Their K-12 education differs, accordingly. Men's education revolves mostly around religious studies, whereas women's K-12 education is more conventional, including mathematics, languages, and basic English.

Studying why JCT CS female students decide to study CS was therefore a unique opportunity to gain insight about the role that the cultural context plays.

Research Questions and Rationale

Our research questions were as follows:

(1) What factors motivate the female undergraduate students at JCT to study CS?

(2) Are the factors that motivate Haredi students to enroll in the CS program unique?

   a. Is there a difference between the factors that motivate Haredi and non-Haredi students to enroll in the CS program?

   b. Is there a difference between these two groups and women in Western and non-Western countries?

We hypothesized that Haredi and non-Haredi women would differ in the factors that motivated them to study CS because of the unique lifestyle of Haredi society. We assumed that the non-Haredi women would resemble women in the West, since they are integrated into Israeli, Western-like society. We also assumed that to some extent Haredi women would resemble the women in Malaysia and Mauritius, since they live in traditional societies.

METHODOLOGY

We employed a mixed methods methodological approach in order to achieve comprehensive answers to the research questions (Creswell, 2013; Venkatesh, Brown, & Bala, 2013). Specifically, we used a qualitative study followed by quantitative studies, according to a sequential strategy of a mixed methods approach. Our main research tool was a questionnaire administered to all the female students enrolled in the CS program at JCT. For the purpose of constructing the questionnaire, we conducted group interviews with students, in order to get a sense of the factors underlying students' decisions to enroll in the CS program and their experience with CS studies. In our analysis of the group interviews, we focused on eliciting the main repeating themes, which were then used as a basis for the questionnaire items. We also included items that did not emerge during the interviews, yet were mentioned in the literature, such as the perception of CS as masculine and "nerd-ish".

PARTICIPANTS

At the time that the data were collected, there were 853 female students enrolled in the CS program (549 Haredi; 304 non-Haredi). As mentioned, we first conducted group interviews of female students enrolled in the CS program. We conducted 3 such interviews, each with 6 students, with a total of 18 students. We selected interviewees who represent various social sub-groups and students who differ in their educational background. The questionnaire was administered to all of the CS undergraduate female students at JCT; a total of 449 students answered the questionnaire (52% of the entire CS female population that year).

RESEARCH TOOLS

Group interviews. We used a semi-structured format for group interviews with female CS students. We asked them to discuss the factors that motivated them to enroll in the CS program as well as their opinions about what deters or attracts women from and to the field. The protocols of the group interviews have been transcribed and analyzed thematically (Graneheim & Lundman, 2004; Patton, 1987).

Questionnaire. The questionnaire consisted of 43 items (presented in Table 1). The items were based on repeated citations from the group interviews as well as on factors found in the literature. The questionnaire's items used a Likert rating scale with a five-point scale (ranging from 'not at all' to 'very much', or 'strongly disagree' to 'strongly agree'). The questionnaires were analyzed statistically. In our analysis, we focused on ranking the factors in order to gain insights into the importance the participants attributed to them. We compared the scale of the factors attributed by the Haredi female students to that of all the non-Haredi female CS students.

Reliability and Validity

Group interviews. We chose 18 students from different social and educational backgrounds as much as possible, aiming to capture a variety of viewpoints (Corbin & Strauss, 1990). About half of them were Haredi. In order to achieve a consistent analysis of the group interviews, each of us analyzed the transcripts separately. Then, we compared the analyses and discussed and resolved our disagreements.

Questionnaire. Initially, the questionnaire included 72 items. In order to validate the questionnaire, we correlated each item with items that seemingly belong to the same category. Specifically, we used Item Analysis, and remained with 43 of the 72 items—only those items that were correlated with the items that belonged to the same factor. Correlational values provided evidence indicating that there is enough commonality to justify 9 factors that are significant to the research questions: family & career, economic basic well-being, status, self-realization, the influence of family/somebody, self-efficacy & affinity, gender variable, economic improved well-being, and stereotype. The reliability of the scale was measured by Cronbach α values within each category. Table 1 includes information on

the number of items (according to Table 1) for each factor and Cronbach's α. The obtained Cronbach's α shows good internal consistency.

Table 1: Factors, Items & Cronbach's α

FACTOR	ITEM	**Total number of items**	**Cronbach's α**
Personal –Self-efficacy & affinity	I am interested in the field.	10	.841
	I am very good in Mathematics, which helps a lot in studying CS.		
	I like the field of CS very much.		
	It enables me to use my abilities to the fullest.		
	I have no problem with sitting in front of a computer all day.		
	Though the studies are very difficult, they are very interesting.		
	Though CS is difficult, it is amazing.		
	Though CS is difficult, there are terrific courses!		
	I enjoy studying CS by itself.		
	It is very satisfying to succeed after working so hard.		
Personal- status	It provides a high social status.	5	.846
	It provides prestige and a good reputation.		
	It provides an evaluated status.		
	Computer jobs are considered honorable.		
	It enables one to implement initiatives.		
Personal - self-realization	It requires continuous intellectual activity.	6	.626
	It enables one to fulfill initiatives and to be creative.		
	It is a challenging profession.		
	It enables me to use my abilities to the fullest.		
	The studying requires a high level of intellectual activity.		
	It enriches knowledge and is accompanied by extensive insights and information.		
Social – gender variable	Women who are programmers have realistic and logical thinking.	6	.737
	Each job can be combined with family life if you use appropriate limits.		
	The world is developing towards more use of computers, and there is place for both women and men.		

FACTOR	ITEM	Total number of items	Cronbach's α
	Women are usually creative; hence, CS is suitable for them.		
	Women are accurate; hence, CS is suitable for them.		
	Working female programmers advised us not to study CS.		
Social – influence of family/somebody	My parents pressured me to study CS.	3	.702
	I wanted to be like some programmers in my family.		
	There were some that advised me to enroll in CS studies.		
Social – family & career	It provides free time to spend with the family.	5	.428
	High-tech jobs are demanding and might harm family life.		
	Though CS is a field incompatible with family life, I am ready to invest in it.		
	Family life is my top goal; nevertheless, I will succeed in combining it with work.		
	I plan not to advance at my work in order not to harm my family life.		
Professional - Stereotype	CS majors and workers are boring people.	3	.570
	People often consider CS as a masculine field.		
	Typically, a CS major is good in Mathematics.		
Economic - Economic basic well-being	CS enables establishing a good economic foundation.	2	.595
	CS studies enhance job opportunities.		
Economic - Economic improved well-being	The financial rewards were very significant as a reason in my decision to study CS.	2	.636
	In many jobs it is difficult to combine work with family, but CS at least provides high-paying salary.		

RESULTS

GROUP INTERVIEWS

When asked why they chose to enroll in CS studies, the answers in all three groups revolved around three factors: (a) self-realization, e.g., "It is challenging"; (b) self-efficacy and affinity to CS, e.g., "It is exciting to solve computing problems"; and (c) economic well-being, e.g., "The economic consideration was crucial".

CS was perceived as having "promising well-paying jobs". Some Haredi students mentioned that CS would enable them to get a job and support a husband who would dedicate himself to study the Torah. Many students, both Haredi and non-Haredi, referred to their desire to have a big family, and

studying CS was perceived as a means to support such a family. For example, one said, "I want a big family and for this I need to be economically well established".

The students seemed aware of tension between having a demanding career in CS and having a big family, as evident in this excerpt: "High-tech jobs are demanding and might harm family life". Yet, they felt they could deal with this tension. The following two quotes exemplify this feeling: "Though CS is a field incompatible with family life, I am ready to invest in it" and "Family life is my top goal; nevertheless, I will succeed in combining it with work."

The negative images of CS, found when studying perceptions of CS in Western countries, such as its masculine and asocial (geek or nerd-ish) nature, were not mentioned spontaneously by any of the participants. When asked specifically about it, they disagreed, for example: "I don't agree with the claim that CS is a masculine field" and "I have no problem with sitting in front of a computer all day". On the contrary, they thought CS is a feminine field, explaining that "women are usually creative, hence CS is suitable for them", "CS is suitable for women because the field requires accuracy", "women are good team workers", and "Women have no problem with mathematical or logical thinking, hence CS is suitable for them". They further explained that in a mixed-gender society women "might become shy and let the men come forward and solve the problem". The issue of status did not emerge spontaneously as well. We did not ask them about it.

When asked, participants said that they did not know any female role models before they enrolled in the CS program. One of them explained that although she studied CS in high school with a female teacher "that teacher did not work in industry so she was not a role model for me". Two participants added that the women they knew advised them not to take CS studies.

QUESTIONNAIRE

The importance of the various factors. As mentioned above, using item analysis, we identified nine factors underlying women's enrollment in the CS program at JCT. These factors are presented in Table 2 in descending order of the importance attributed to them by the participants (N=499). Using variance analysis (Repeated Measures ANOVA), we found that there is a significant statistical difference in the powers of the various factors ($F(8, 3376) = 692.83$, $MSE = 86.604$, $p < .001$, partial $eta^2 = .204$). Namely, the participants attributed significantly different importance to the various factors.

Table 2. The factors rated according to scores

FACTOR	M	SD
Family & career	3.947	0.5824
Economic basic well-being	3.892	0.9025
Status	3.517	0.9558
Self-realization	3.452	0.6384
Influence of family/somebody	3.281	1.080
Self-efficacy & affinity	2.930	0.8395
Gender variable	2.871	0.8421
Economic improved well-being	2.765	1.183
Stereotype	2.587	0.8967

The factor *family & career* was rated as the most important factor. Interestingly, *economic basic well-being* was rated high, whereas *economic improved well-being* was rated low. Hence, the participants attributed more importance to the ways they need to combine their family responsibilities with their career in order to make a living, but they are less concerned with the financial rewards. The need to balance

between family and career was found as a factor in other studies as well, both in Western and other countries.

The *stereotype* and the *gender variable* (i.e., its suitability for women) factors received low importance, whereas *status* and *self-realization* received relatively high importance. In this respect, our participants resemble the women in Mauritius (Adams et al., 2003) and Malaysia (Lagesen, 2008).

The differences between Haredi and non-Haredi women. Figure 1 presents a comparison between Haredi and non-Haredi female CS students with respect to the importance attributed to the various factors (according to the table in the Appendix). It also shows the rank of the factors within each group (left-*non-Haredi*; right- *Haredi*).

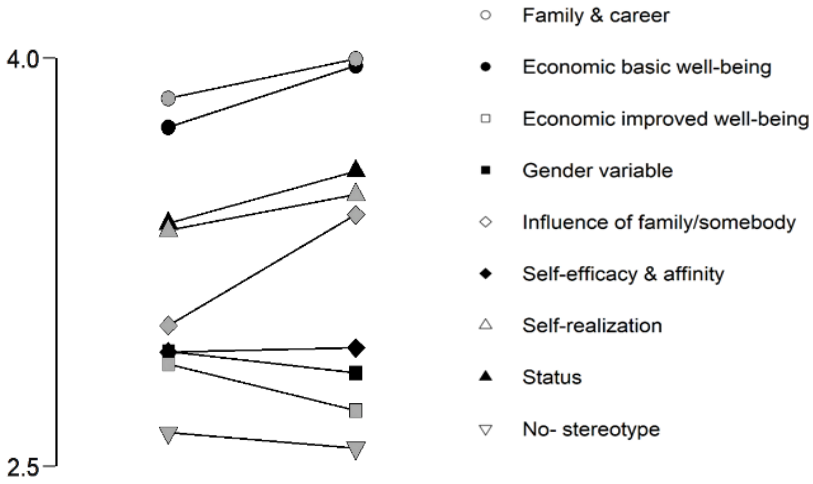

Figure 1. The rate of the factors according to Haredi/ non-Haredi women

The two groups ranked the factors' importance in the same descending order. However, the factors' powers were different. Using variance analysis (Repeated Measures ANOVA), we found that these differences are statistically significant ($F(8, 3376) = 24.84$, $MSE = 3.105$, $p < .001$, partial $eta^2 = .009$).

In order to identify which factor, among the sub-groups, is significantly different, we conducted an Independent t-test, presented in Table 3.

Table 3. Independent Samples T-Test

FACTOR	t	df	p	Cohen's d
Career & family	-2.470	422.0	0.014	-0.251
Economic basic well-being	-2.476	422.0	0.014	-0.252
Status	-1.990	422.0	0.047	-0.202
Self-realization	-2.024	422.0	0.044	0.206
Influence of family/somebody	-3.754	422.0	< .001	-0.382
Self-efficacy & affinity	-0.181	422.0	0.856	-0.018
Gender variable	0.911	422.0	0.363	0.093
Economic improved well-being	1.417	422.0	0.157	0.144
Stereotypes	-0.623	422.0	0.533	-0.063

The highest variance was found in the factor the *influence of family or somebody*: the Haredi students rated it significantly higher than the non-Haredi students did ($p<0.01$). A significant variance was also found in the factors *career & family*, *economic basic well-being*, *status,* and *self-realization*: The Haredi group rated them significantly higher than the non-Haredi group did.

Regarding the *economic improved well-being,* here the non-Haredi sub-group rated it higher, though there is not a significant variance. The factors *self-efficacy & affinity, stereotypes*, and *gender variable* were found to have no statistically significant difference.

DISCUSSION

The purpose of our study was to gain insights into reasons underlying women's underrepresentation in the CS field, especially regarding the role that the local culture plays in their decisions regarding CS studies. JCT, where this study was conducted, serves as an interesting opportunity to gain insights into this topic because of the high proportion of CS female students in it and its cultural diversity.

In comparing Haredi and non-Haredi students, we found that the two groups, Haredi and non-Haredi students, ranked the factors' importance in the same decreasing order. Furthermore, the results of the questionnaires echo those of the group interviews. Specifically, the same factors that were rated with high importance (*family & career, economic basic well-being, status, self-realization*) are those that were invoked spontaneously during the group interviews. The factors that were rated as less important (*stereotype* and *gender variable*) were not mentioned spontaneously in the group interviews.

However, we found statistically significant differences in the importance that Haredi and non-Haredi students attributed to different factors relevant to their decisions to study CS, namely, *family & career, economic basic well-being, status, self-realization,* and the *influence of family* were statistically significantly different. In the remaining factors—*self-efficacy & affinity, gender variable, economic improved well-being*, and *stereotypes*—no statistically significant differences were found.

Moreover, both groups, Haredi and non-Haredi, did not completely resemble the descriptions in the literature both in Western countries and countries with a high proportion of CS female students. In this section we will first discuss the findings with respect to the cultural context of the students.

The factor of family and career was ranked as the most important factor by the two groups. This indicates that tension exists when career and family are combined. This is one of the factors reported in the literature as deterring women from entering the field of CS in Western countries (Beyer, 2014; Eccles et al., 1999). The Malaysian women studying CS were also bothered by that topic (Lagesen, 2008). In fact, many of them wanted to become university lecturers, owing to the flexibility inherent in such jobs. The participants in our study were also aware of the tension, as can be seen by their strong agreement with items that constitute this factor, such as "though CS is a field incompatible with family life, I am ready to invest in it" and "family life is my top priority; nevertheless I'll succeed in combining it with work". Nonetheless, they pursued a career in the field. This factor, the tension between family and a demanding career, unifies women in the West and developing countries, though with different outcomes. In the West, it deters women from entering the CS field, whereas in Israel and in Malaysia, other factors overcome this barrier. The factor *family & career* is rated higher by the Haredi students in comparison with the non-Haredi students.

The factor of *economic basic well-being* was ranked as the second most important by the two groups. However, Haredi women ranked it significantly higher than did the non-Haredi women. This factor expresses the unambiguous consideration of basic economic needs. It could be that the Haredi students are motivated mainly by their economic needs because of their unique lifestyle, in which the women are recognized as the breadwinners of the family. The need for well-paying jobs is crucial in their decision to choose to study CS, in spite of the difficulty to combine it with family life. This explanation might be strengthened by the findings that the *economic improved well-being* factor was rated low by the two groups, but was rated lower by the Haredi students, though it was not statistically sig-

nificant. They are concerned with basic economic needs and are less concerned with the financial rewards.

In Mauritius and Malaysia the financial rewards of working in CS is a crucial factor that attracts women to the field (Adams et al., 2003; Lagesen, 2008), whereas in the West, the amount of money to be earned in the field did not significantly influence women in deciding not to study CS (Carter, 2006). In a developing country, like Mauritius and Malaysia, the need for economic well-being is crucial.

The factors of *status* and *self-realization* were given relatively high importance. These results resemble those of studies conducted on women in Mauritius (Adams et al., 2003) and Malaysia (Lagesen, 2008). However, there was a statistically significant difference between the two groups. A plausible explanation is that since Haredi women are more concerned with providing for their families and combining their work with raising their families, their self-realization, and status, although are favorable, play an ancillary role in their considerations. The fact that the factor of the *influence of family or somebody* was ranked significantly higher supports this explanation. The importance they attributed to this factor and the statistically significant difference with the non-Haredi group probably mirrors the cultural differences between the two groups; Haredi women are less free to make decisions about their career.

The influence of the family is not unique to Haredi women. In fact, Western women's decision to study CS is often influenced by the opinions of those close to them (Beyer, 2014; Siek et al., 2006; Yasuhara, 2008). However, usually this factor has opposite results, since this influence was reported to deter women from studying CS. In Mauritius (Adams et al., 2003) and Malaysia (Lagesen, 2008), it was found that parents or family members strongly encourage or even pressure their children to pursue a career in a field like CS, because of the associated prestige or financial rewards.

Interestingly, the factors where no statistical difference was evident are those that both groups rated as having low importance. The two groups rated *self-efficacy & affinity* as having low importance. In this respect, they resemble the results in the West (Beyer, 2014; Wilson, 2002).

The factors of *stereotype* and *gender variable* received low importance by the two sub-groups with no significant statistical difference. In fact, these two factors did not emerge in any of the group interviews. These findings resemble the absence of gender variables associated with CS and the negative stereotypes of CS scientists and workers in Mauritius (Adams et al., 2003) and Malaysia (Lagesen, 2008). Moreover, like in Mauritius and Malaysia, the participants in this study see the CS field as suitable for women. These findings strengthen our belief that the image of CS as a masculine domain and the negative stereotypes of CS people, prevalent in the Western world, are culturally dependent (Beyer et al., 2003; Falkner et al., 2015; Leiman et al., 2017; Singh et al., 2007; Camp, 1997).

Our findings also highlight that gender issues, the (perceived) social expectations from each gender and the relationship between the genders are culturally dependent; this is also reflected in women's underrepresentation in CS. For example, women all over seem to attribute much importance to the factor of family and career. But this factor is interleaved differently in every culture owing to other factors.

CONCLUSIONS

We found statistically significant differences between Haredi and non-Haredi CS female students regarding what they view as important factors in their decisions to study CS. The views of both groups did not fully overlap with either the West or the two developing countries. These findings strengthen the hypothesis that women's enrollment in CS programs and their views of CS are culturally dependent.

These findings carry important implications for resolving women's underrepresentation in CS. Future research should focus on addressing each factor deemed important within the cultural context stud-

ied. Different solutions are required in every culture, since these solutions address different socially dependent dimensions of women's lives and their varied perceptions of variables such as their career, family, role, their spouse's role, and so forth. It is important to study how these groups of women decided to embark on their CS studies and what occurred later in their careers, especially regarding what problems and solutions emerged when they combined their careers with their family life, and what they thought is needed for them to succeed.

REFERENCES

Adams, J. C., Bauer, V., & Baichoo, S. (2003). An expanding pipeline: Gender in Mauritius. *ACM SIGCSE Bulletin*, *35*(1), 59-63. https://doi.org/10.1145/611892.611932

Asgari, S., Dasgupta, N., & Stout J. G. (2012). When do counterstereotypic ingroup members inspire versus deflate? The effect of successful professional women on young women's leadership self-concept. *Personality and Social Psychology Bulletin, 38,* 370-383. https://doi.org/10.1177/0146167211431968

Ben-David Kolikant, Y., & Genut, S. (2017). The effect of prior education on students' competency in digital logic: The case of ultraorthodox Jewish students. *Computer Science Education*, *27*(3-4) 149-174. https://doi.org/10.1080/08993408.2017.1414364

Beyer, S. (2014). Why are women underrepresented in computer science? Gender differences in stereotypes, self-efficacy, values, and interests and predictors of future CS course-taking and grades. *Computer Science Education, 24*(2-3), 153-192. https://doi.org/10.1080/08993408.2014.963363

Beyer, S., & Haller, S. (2006). Gender differences and intra-gender differences in computer science students: Are female CS majors more similar to male CS majors or female non-majors? *Journal of Women and Minorities in Science and Engineering, 12*(4), 337-365. https://doi.org/10.1615/JWomenMinorScienEng.v12.i4.50

Beyer, S., Rynes. K., Perrault. J., Hay. K., & Haller, S. (2003). Gender differences in computer science students. *ACM SIGCSE Bulletin*, *35*(1), 49-53. https://doi.org/10.1145/611892.611930

Camp, T. (1997). The incredible shrinking pipeline. *Communications of the ACM, 40*(10), 103-110. https://doi.org/10.1145/262793.262813

Carter, L. (2006). Why students with an apparent aptitude for computer science don't choose to major in computer science? *ACM SIGCSE Bulletin*, *38*(1), 27-31. https://doi.org/10.1145/1121341.1121352

Corbin, J., & Straus, A. (1990). *Basis of qualitative research: Grounded theory procedures and techniques*. Newbury Park, CA: Sage publications.

Creswell, J. W. (2013). *Research design: Qualitative, quantitative, and mixed methods approaches*. Thousand Oaks, California: Sage publications.

Dee, H. M., Petrie, K. E., Boyle, R. D., & Pau, R. (2009). Why are we still here? Experiences of successful women in computing. *ACM SIGCSE Bulletin, 41*(3), 233-237. https://doi.org/10.1145/1562877.1562951

Eccles, J. S., Barber, B., & Jozefowicz, D. (1999). Linking gender to educational, occupational, and recreational choices: Applying the Eccles et al. model of achievement-related choices. In W. B. Swann Jr, J. H. Langlois, & L. A. Gilbert (Eds.), *Sexism and stereotypes in modern society: The gender science of Janet Taylor Spence* (pp. 153–192). Washington: American Psychological Association. https://doi.org/10.1037/10277-007

Falkner, K., Szabo, C., Michell, D., Szorenyi, A., & Thyer, S. (2015), Gender gap in academia: Perceptions of female computer science academics. *Proceedings of the 2015 ACM Conference on Innovation and Technology in Computer Science Education* (pp. 111-116). New York: ACM. https://doi.org/10.1145/2729094.2742595

Graneheim, U. H., & Lundman, B. (2004). Qualitative content analysis in nursing research: Concepts, procedures and measures to achieve trustworthiness. *Nurse Education Today, 24*(2), 105-112. https://doi.org/10.1016/j.nedt.2003.10.001

Jones, T., & Clarke, V. A. (1995). Diversity as a determinant of attitudes: A possible explanation of the apparent advantage of single-sex settings. *Journal of Educational Computing Research*, *12*(1), 51-64. https://doi.org/10.2190/3HPH-1E8N-XTMW-CANR

Lagesen, V. A. (2008). A cyberfeminist utopia? Perception of gender and computer science among Malaysian women computer science students and faculty. *Science, Technology & Human Values*, *33*(1), 5-27. https://doi.org/10.1177/0162243907306192

Leiman, K. J., Sax, L. J., & Zimmerman, H. B. (2017). Women planning to major in computer science: Who are they and what makes them unique? *Computer Science Education*, *26*(4), 277-298. https://doi.org/10.1080/08993408.2016.1271536

Levi, R. (2017, August 20). Women make up just 29% of all Israeli computer science students. Data obtained by The Marker show rate is highest at Haredi Lev Academic Center in Jerusalem. *Haaretz Daily Newspaper*. Retrieved from https://www.haaretz.com/israel-news/business/women-make-up-just-29-of-all-israeli-computer-science-students-1.5444412

Malach, G., Choshen, M., & Cahaner, L. (2016). *The year book of ultra-orthodox society in Israel*. Jerusalem, Israel: The Jerusalem Institute of Israel Studies.

Michell, D., Szorenyi, A., Falkner, K., & Szabo, C. (2017). Broadening participation not border protection: How universities can support women in CS. *Journal of Higher Education Policy and Management, 39*(4), 406-422. https://doi.org/10.1080/1360080X.2017.1330821

Parker, L. H., & Rennie, L. J. (2002). Teachers' implementation of gender-inclusive instructional strategies in single-sex and mixed-sex science classrooms. *Journal of Science Education, 24*, 881-897. https://doi.org/10.1080/09500690110078860

Patton, Q. M., (1987). *How to use qualitative methods in evaluation*. Newbury Park, CA: Sage publications.

Siek, K. A., Connelly, K., Stephano, A., Menzel, S., Bauer, J., & Plale, B. (2006). Breaking the geek myth: Addressing young women's misperceptions about technology careers. *Learning & Leading with Technology, 33*(7), 19–24. International Society for Technology in Education (ISTE). Retrieved from https://files.eric.ed.gov/fulltext/EJ779805.pdf

Singh, K., Allen, K., Scheckler, R., & Darlington, L. (2007) Women in computer related majors: A critical synthesis of research and theory from 1994 to 2005, *American Educational Research Association, 77*(4), 500-533. https://doi.org/10.3102/0034654307309919

Wilson, B. C. (2002). A study of factors promoting success in CS including gender differences. *Computer Science Education, 12* (1-2), 141-164. https://doi.org/10.1076/csed.12.1.141.8211

Yasuhara, K. (2008). *Viewpoints from the doorstep: Pre-major interest in and perceptions of computer science*. Doctoral Dissertation. Seattle, WA: University of Washington. Retrieved from http://staff.washington.edu/yasuhara/cv/publications/dissertation/Yas08.dissertation-Viewpoints_from_the_doorstep.pdf

Venkatesh, V., Brown, S. A. & Bala, H. (2013). Bridging the qualitative-quantitative divide: Guidelines for conducting mixed methods research in information systems. *MIS Quarterly, 37(1)*, 21-54. https://doi.org/10.25300/MISQ/2013/37.1.02

APPENDIX

Factors' scores of Haredi / non-Haredi women

FACTOR		Career & family	Economic basic well-being	Status	Self-realization	Influence of family/ somebody	Self-efficacy & affinity	Gender variable	Economic improved well-being	Stereotype
Non-Haredi (N=149)	**M**	3.852	3.745	3.392	3.367	3.018	2.920	2.922	2.876	2.624
	SD	0.595	0.946	1.001	0.728	1.118	0.957	0.896	1.183	0.867
Haredi (N=275)	**M**	3.998	3.971	3.585	3.498	3.424	2.936	2.844	2.705	2.567
	SD	0.570	0.870	0.925	0.581	1.034	0.770	0.812	1.182	0.913

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